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Drivers and material pushed to the limit: endurance racing is the ultimate test of durability in motorsports. The year 2023 ushers in a new era for one of the most important and prestigious forms of motorsports with the new prototype class – Le Mans Daytona hybrid (LMDh). Bosch Motorsport is lining up to prove its expertise, endurance, and performance as the supplier of the unified hybrid system.

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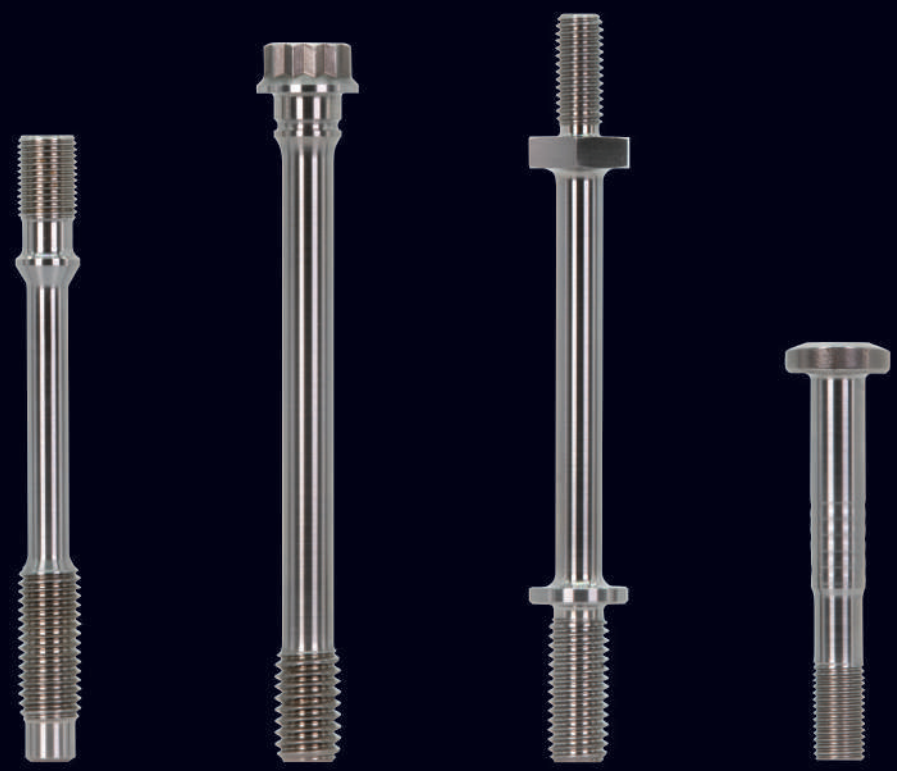

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William Kimberley

EDITOR
Mark Skewis

HEAD OF OPERATIONS & DIGITAL
Sara Kimberley

PHOTOGRAPHY
LAT

ART EDITOR
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ACCOUNTS
Fiona Keeble

ADVERTISING EXECUTIVE
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RACE TECH INTERNATIONAL
Motorsport Engineering

841 High Road, Finchley
London N12 8PT
Tel: +44 (0) 208 446 2100
Fax: +44 (0) 208 446 2191

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GUARD AGAINST GREENWASHING!

PEOPLE used to complain about the smell of rocket fuel in the pit lane. Now it's the slightest whiff in the air of 'greenwashing' that gets them really agitated.

So it was interesting to hear Ellen Jones, Formula 1's first head of sustainability, update us this month on the sport's ambitious plans to be Net Zero by 2030. Fascinating too, to discover elsewhere in this issue how suppliers have been impacted by motorsport's reaction to the climate crisis.

ATL and AP Racing (reacting to sustainable fuels and electrification respectively) have both had to adapt to emerging trends. As has Ru-bix Advanced Materials – winner of the William Kimberley Green Tech Award at our recent World Motorsport Symposium – which is helping pioneer a more responsible wave of motorsport engineering in a composites sector that, let's face it, is awesome for its technology but makes you squirm when we talk about sustainability.

Wherever you look, the task is immense, but we have to start somewhere. So I confess that I was initially irked by the World Rally Championship's decision to axe its hybrid system after having invested so much time, expense and effort – not least in telling us just how sustainable it was being!

What message does ditching hybrids send, I asked myself. On reflection, I realise that it shouldn't just be all about the 'message'. What about the reality, because the reality was that the spec hybrid system stank of merely paying lip service to the concept of being green.

The truth is that the electric range was an embarrassment and after the initial excitement of exploiting the grey areas in the rules – 'kickdown', anybody? – insiders have long derided the WRC's timid hybrid system. Outwardly, they talked the talk, but they hated the system's weight and, most of all, the cost.

The World Rally Championship's blueprint for life after hybrids (see page 8) is at least refreshingly pragmatic. It strikes me as a viable vision for the future, rather than the latest in a spate of knee-jerk reactions. In places it is, shall we say, a little vague, but the principle is that it stays flexible to adapt to whatever propulsion technology is coming down the line. In that respect it is a reflection of the current automotive landscape, where a plethora of different technologies cater for different situations in different markets.

'WRC27' is underpinned by a much-needed focus on cost containment, and growing participation at the top level of rallying. Crucially, it retains the use of sustainable fuel – an area where we really do need to use motorsport as a laboratory in order for us to make progress.

The new rules cap budgets for a Rally1 car to €345,000, compared to the nearly €1.5 million that cost had spiralled to for the very top cars. That amounts to quite a big acknowledgement: there is no point trumpeting sustainability if the series itself is not financially sustainable in the first place for anyone to enter it. RT

Mark Skewis
EDITOR

IS THIS INDYCAR'S *'GO BIG OR GO HOME'* MOMENT?

Calls for IndyCar to explore along the lines of Adrian Newey's radical X1 concept as team owners divided over proposed 2027 design. By **Mark Skewis**

PLAY it safe, or go for broke? That's the dilemma dividing IndyCar team owners as they contemplate the design of the car that will carry the series into a new era from 2027.

Penske Entertainment revealed the first rendering of its proposed replacement for the current Dallara DW12 design during a private teleconference with its team owners. IndyCar's parent company was seeking to provoke a debate and succeeded: it ignited some strong opinions from owners and, subsequently, fans too.

At the heart of the debate lay the old conundrum of whether to pursue evolution or revolution. Reportedly, Penske Entertainment's first offering opted for the former route. Its next-generation IndyCar would carry over as many of the current DW12's mechanical components as possible – suspension, some drivetrain items and ancillaries – in order to keep costs down. The result, we're told, was a lightly modified version of today's car, with a large, F2-style rear wing array, which has already tested as a scale model in Dallara's wind tunnel.

You've got mail...

That's where the tale of IndyCar's 2027 challenger got really interesting. One team owner sent an email (to most of his counterparts), calling for a complete makeover of the 2027 concept. We've all hit 'send' to fire off one of those off-the-cuff emails, only this one contained an attachment: a photo of the Red Bull X1 open-wheel concept (subsequently rebranded X2010) penned by Adrian Newey. The outgoing Red Bull tech chief's digital creation – which made it as far as a video game and a full-size model displayed

Red Bull Content Pool

BELOW Adrian Newey's X2010 prototype has been proposed as an example of the route IndyCar should explore for its 2027 car

RIGHT The current Dallara DW12 has morphed through many different configurations in its extended service life, including the manufacturers' aero kits

at Goodwood – is now being hailed as an example of the futuristic design direction that a number of owners have urged IndyCar to investigate.

"Let's make a car that people talk about outside of IndyCar," Meyer Shank Racing co-owner Michael Shank told *Racer*. "Let's up the game. Let's turn it up a notch with something that really brings people back to IndyCar. Design-wise, let's get it out there, visually, because we're all in the same car. Let's make a car that's appealing.

"My heart that loves IndyCar racing wants a clean sheet (design), right? Because ultimately, that's what we really need. We need every tool we can to draw new people in, and I think a new car, a really wild concept, is important in how we get there. Think about what Adrian Newey came up with a couple years ago with that X1 car. Maybe it's not exactly that, but that's where we should be thinking."

Dale Coyne Racing owner Dale Coyne was equally underwhelmed with the first proposal. "It's not futuristic. It looks the same," he said. "It's like the current car. You updated it by a couple or three years. It doesn't look like a modern car.

"I think we can take a bigger step. There should have been two steps beyond . Let's make something that has a 'wow factor' that gamers would look at and say, 'Yeah, that's really cool.'"

Rahal Letterman Lanigan co-owner Bobby Rahal wasn't as strident with his reaction, but did reference the Newey concept as an alternative.

"I didn't get the sense what we were presented with was a done deal," Rahal said. "I got the sense that it was a 'Here's where we're thinking of going, these are the areas we're thinking of pursuing, let us know what you're thinking.'

"Adrian Newey did a concept that was pretty amazing, right? And especially now that we have the aeroscreen, I'm quite sure that car incorporated a cockpit with a windscreen. Last year Adrian and I were having dinner and he said, 'The thing everybody forgets is nobody really cares what radiator size you have, or if you have strakes on the car or not. They care about the overall look of the car. That's what excites them.' And I did tell that to IndyCar.

"So how do you produce a car that is simple and yet just so compelling isn't going to be easy, but that's the challenge."

"The number one priority isn't to see how inexpensively we can do it, but cost is going to be a consideration as things get developed more narrowly," responded Penske Entertainment CEO Mark Miles.

"Dallara is on point to develop the chassis with lots of other supplier partners, and it is very much work in progress. So from my perspective, we were not looking for a referendum the first time we put renderings of the car forward. We wanted feedback. And it continues to be. It is changing. It will change."

The DW12 chassis has certainly stood the test of time. The Dallara-penned chassis has undergone significant alterations since it entered service: manufacturer aero kits (2015-2017); a return to spec bodywork (2018) with a Universal Aero Kit; the introduction of the Aeroscreen (2020); and the hybrid powertrain in 2024.

When the DW12 was first conceived, the open-wheel single-seater was miles away from Newey's original X1 concept. The addition of the aeroscreen, however, brings it visually much closer to the closed canopy of the Red Bull concept. And Newey's proposed addition of fan car technology to his creation carries it much closer to the machinations that have surrounded a controversial new car on this side of the Atlantic: Formula 1's new car.

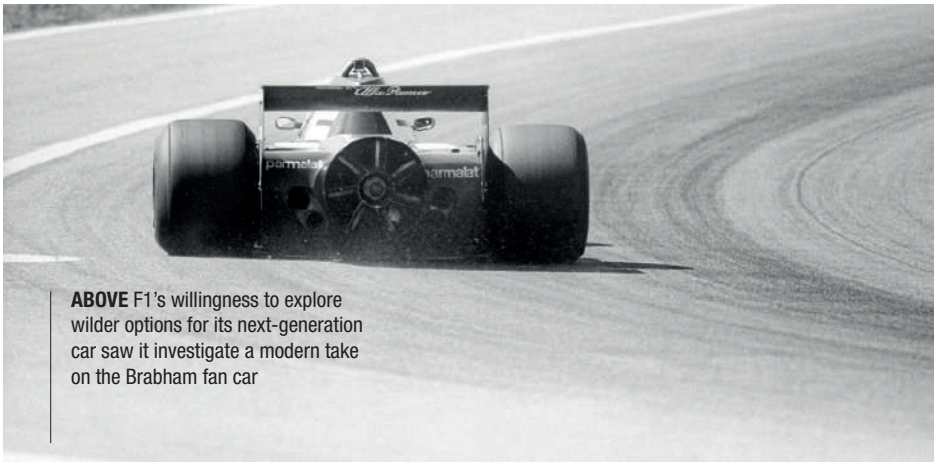
F1 revisits fan car

Formula 1 has just undergone a similar, at times torturous process with its own next-generation car, releasing the 2026 aerodynamic regulations before Christmas. Its aero department explored – and abandoned – many different concepts for the new car. A few of them were refreshingly radical, including a modern take on Gordon Murray's controversial Brabham fan car.

Ultimately, it opted to generate downforce in a different manner, moving away from its return to ground-effect. Instead, it is harnessing unprecedented use of active aero for 2026 and the introduction of a powertrain-operated 'push to pass' system that replaces the Drag Reduction System to assist overtaking.

While Formula 1's 2026 solution divides drivers and fans, much like IndyCar's deliberations, its was arrived at through a collaborative process with the teams, which saw it share its data – in a two-way process – at various stages along the way.

McLaren CEO Zak Brown, who runs an IndyCar squad in addition to the Constructors' Championship-winning McLaren Racing, referenced F1's collaborative approach in discussions on the new IndyCar.



ABOVE F1's willingness to explore wilder options for its next-generation car saw it investigate a modern take on the Brabham fan car

Flexible future for WRC27

A REIMAGINED World Rally Championship for 2027 will cater for a variety of production shapes and bespoke designs, feature a 50 per cent reduction in cost over the current cars, and be open for teams and tuners to homologate a car.

The planned regulations cycle, the first of the WRC's post-hybrid era, will last for 10 years. Mindful of the fast-changing automotive landscape, the new rules are intended for flexibility – giving the series the chance to incorporate new propulsion methods if need be.

At the heart of the new cars lies a common safety cell, based on the current generation Rally1 cars, to reduce complexity and cost.

This then allows bodywork from almost any scaled production car to be fitted to the safety cell, meaning that hatchbacks could conceivably compete against saloons, SUVs, and there's even the possibility for bespoke rally concept designs to take to the stages from 2027.

With cost control identified as the biggest obstacle to attracting more entries, costs will be capped at €345k. This represents more than a 50 per cent reduction when compared to the outgoing formula.

These savings will be achieved though component cost specifications rather than financial regulations. There will also be savings in the technical designs of certain components that will make them more durable over the course of a rally. Running costs will also be reduced by limiting personnel, reducing logistics transport costs, increasing the use of local facilities and increasing data connectivity to aid offsite engineering.

The WRC27 regulations not only provide for variety of bodywork, but also of powertrains. Although the initial target is for competitors to utilise sustainably-fuelled ICE in 2027, diversification including hybrid systems, or fully electric technologies, could be introduced at a later stage.

"We need to have new entries, more teams and drivers competing at the top level, and these regulations for 2027 will encourage this," said Malcolm Wilson, Managing Director M-Sport Ford WRT, the plight of which was one of the catalysts for the regulatory upheaval.

"It will allow us to give more young drivers a chance, which is essential for the long-term success of the sport," he continued. "It's really important that we make the WRC more affordable, allowing teams to compete alongside manufacturers."

Foundations

FIA President Mohammed Ben Sulayem said: "The regulations that we have approved are critical to the long-term growth of the FIA World Rally Championship. They lay the foundations for an exciting future with a focus on cost containment, sustainability and growing participation at the top level of rallying."

The regulations also lay the groundwork for the potential for cross-over between the WRC and the FIA World Rallycross Championship. The latter will initially retain its 'Battle of Technologies' concept, pitching ICE against electric powertrains, but there is potential for the new breed of WRC car to be used.

Although the reality is that there is still much work to make this happen, it is a potentially smart move that will inevitably stir dreams, in much the same way as the redundant Group B rally cars ushered in a golden era for rallycross. RT

LEFT The ability to 'scale' the bodywork opens up the series to more types of vehicle

CONGRATULATIONS TO OUR TECHNICAL PARTNER INVICTA RACING AND GABRIEL BORTOLETO FOR WINNING THE FIA FORMULA 2 DRIVERS AND TEAM CHAMPIONSHIP!

Ferrari to supply Cadillac

FERRARI will supply engines to the new Cadillac team for the 2026 Formula 1 season.

The General Motors-backed entry that was formerly known as Andretti Cadillac is preparing to be on the grid in a year's time, to match up with the start of new aerodynamic regulations. That entry point comes at least two years before GM believes it will have its own power unit ready, meaning it needs a supply deal in the meantime.

The move means Ferrari will continue to have two customer teams in 2026, despite losing Sauber as it becomes the Audi factory entry.

Ferrari team principal Frederic Vasseur said: "It's great to see the commitment of another American team, backed by one of the most highly respected marques in the motor industry, at a time when Formula 1 is increasing in popularity in the United States.

"We are delighted therefore that we will be supplying the team with our power unit and gearbox as the basis of this technical collaboration.

"It means we will continue to have two 'customer teams' in the championship with all the benefits this brings in terms of technical development within Ferrari."

"We are thrilled to partner with Ferrari as the power unit and gearbox supplier for our Cadillac team, bringing together two remarkable legacies," said the GM squad's new team principal, Graeme Lowdon. "Choosing the right power unit partner is crucial, and we trust in Ferrari's passion, excellence and the exceptional capabilities of their people."

ABOVE GM's own engine won't be ready until 2028 at the earliest

F1 increases SAF investment

FORMULA 1 has taken another step on its path to reach its 2030 Net Zero commitments by announcing further investment in Sustainable Aviation Fuel alongside Qatar Airways.

F1 has joined up as the inaugural member of Qatar Airways' SAF programme, strengthening the relationship with one of its global partners as the eight-time Airline of the Year enters the next phase of its own sustainability journey.

The news follows on from an investment with F1's global logistics partner DHL, announced at this year's Singapore Grand Prix.

Ellen Jones, Head of ESG, Formula 1, said: "Our alternative fuels strategy is central to delivering our Net Zero 2030 target. Through collaboration with our teams, the FIA and our partners, we are delivering on our promises to drive down the sport's carbon emissions and drive forward technologies that can have an impact beyond Formula 1. This is the latest example of how stakeholders across the sport are aligned with our vision for a more sustainable F1, which we are thrilled to see."

Multimatic welcomes PKM Consulting

Multimatic | PKM CONSULTING

Wickens lands GTD Corvette deal with Bosch brake system

BOSCH Motorsport's LMDh-inspired electronic hand control brake system has helped propel paralysed racer Robert Wickens into an IMSA GTD program for 2025.

The system, which won Race Tech's recent Don Burgoon Most Innovative New Motorsport Product of the Year award, enables Wickens to brake with a steering wheel-mounted system, rather than using foot pedals.

Wickens, injured in an IndyCar accident in 2018, will drive a five-race IMSA schedule in a DXDT Racing Corvette Z06 GT3.R, most likely starting at Long Beach.

"It's a dream opportunity," Wickens said. "Since I began racing again in the Michelin Pilot series the goal has always been to make it to WeatherTech. It's going to be very difficult, I'm well aware of that. Frankly, I want to be a professional driver again as I was prior to my accident, and this is a massive step forward in that regard."

First used by Wickens in last September's Michelin Pilot Challenge race at Indianapolis Motor Speedway, the Bosch system eliminates the delays and friction associated with the mechanical system previously used on the Hyundai TCR. It allows him to experience more consistency and faster response across the application of brakes and throttle.

"The first key is Bosch," Wickens said. "Coming to the table with their technology and lending a hand on allowing me the chance to drive other cars.

"I always had ambitions to move up into the WeatherTech series but there was always a complicated discussion. It's hard to try to sell myself and say, 'Oh, by the way, you guys will have to engineer a brake system from scratch on top of everything else.'

"That's where Bosch lent a hand, saying, 'We have technology we believe can benefit you.' It was the perfect partnership; the perfect match.

"It's always going to be a little more complicated for me to drive each car than for an able-bodied driver, but (now) all we have to do is adapt a current system into a car. We don't have to design something from nothing and then adapt it to the car."

Another key element in the program is Pratt Miller Motorsports, which is largely responsible for the design of the Corvette Z06 GT3.R. The team has taken the lead in adapting the Bosch system to the DXDT Corvette. Unlike its use on the TCR car, this will be a full brake-by-wire system.

"Pratt & Miller's involvement from the beginning was a no-brainer," said Wickens. "When we were starting on this journey and adapting the hand controls, in theory we could have done it in-house at DXDT. But we're here to have success and to do it right, and no one knows the Corvette GT3 better than Pratt & Miller.

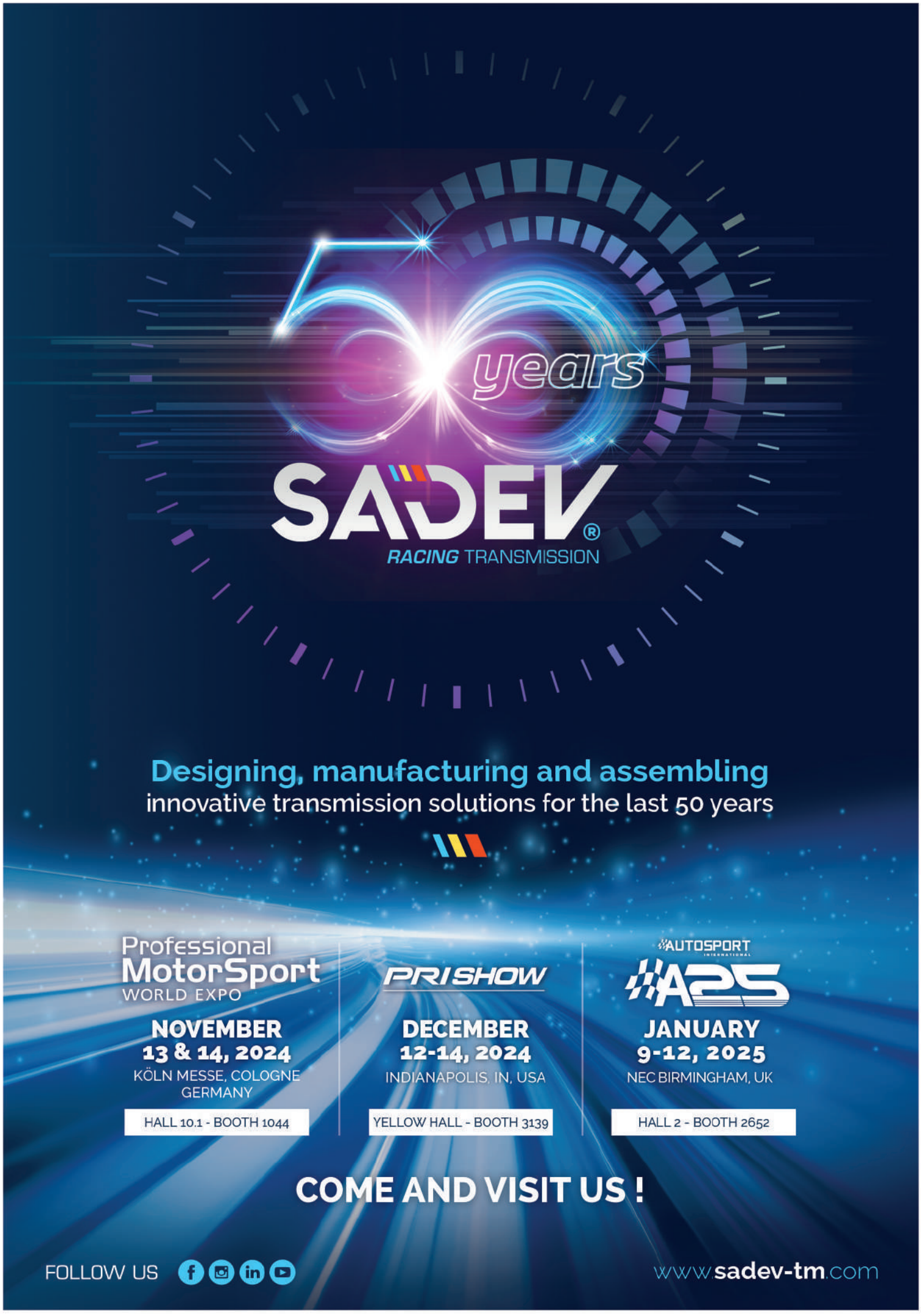
Hard work behind the scenes

"To see so much hard work going on behind the scenes... I think the average person doesn't understand what goes into making this work. It's not as simple as it might sound and frankly, not as simple as I try to make it sound sometimes. I'm so grateful to have this opportunity and the support system around me."

Although Wickens faces a steep learning curve with the Corvette, he is already quite familiar with one key element in the process. Having spent the vast majority of his career racing rear-wheel drive vehicles – from go-karts to Formula 2 to IndyCar and everything in between before tackling the front-wheel drive Hyundai – he relishes the prospects of putting the power to the road via the Corvette's rear wheels.

"The only time I've driven a front-wheel drive race car is the TCR Hyundai Elantra," Wickens said. "And the only car I've driven with hand controls is a front-wheel drive race car. So, I have 10 times the experience with rear-wheel drive cars and if I'm racing on my home simulator, I'm always most comfortable with a rear-wheel drive car." RT

BELOW A full brake-by-wire system is being developed for the Corvette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ABOVE A rendering of the GMR-001

Hyundai "ready for unexpected" as it switches from WRC to LMDh

HYUNDAI Motorsport has officially launched its LMDh program, stressing that its experience in the World Rally Championship equips it well to deal with the uncertainties that await it in endurance racing.

Cyril Abiteboul, who will be team principal for the new sports car squad, run through the South Korean automotive manufacturer's luxury Genesis brand, has recent experience of both Formula 1 and the WRC.

Whilst he acknowledges that endurance racing experience will need to be blended into the team, he believes the skills Hyundai's engineers have honed through world rallying will stand it in good stead for the new challenge.

"For anything that is engineering or performance-related, I think we've got a good group of engineers who are capable of taking into account a huge amount of data and quickly drawing conclusions from it," he said. "I think actually, there are more comparisons between rallying and endurance racing than there are, for instance, between endurance racing and Formula 1, which is a sprint race.

"I've seen mechanics in F1 and I've seen mechanics in rallying, and what probably makes the world of rallying a bit closer to endurance is the fact that when your car is coming back to the service park in rallying, you have absolutely no idea what you'll have to fix, injecting a bit of 'dealing with the unknown and managing the unexpected' – but what you do know is that you'll have a very short period of time to fix it.

"You're never going to think about changing a turbocharger in Formula 1, but that's definitely the sort of thing you have to do in a very limited amount of time in a very controlled manner [in rallying and endurance racing], ensuring reliability and perfection of execution."

At a launch in Dubai Hyundai revealed its team name (Genesis Magma Racing), its new car (the GMR-001), its first two drivers (Andre Lotterer and Pipo Derani) and outlined plans to compete in both the FIA World Endurance Championship and the IMSA WeatherTech SportsCar Championship in the coming years.

The GMR-001 is an LMDh-spec prototype based on an ORECA chassis. It will compete in the FIA WEC first in 2026, before joining IMSA's GTP class with two cars and a to-be-announced partner team in 2027. Track testing will start next summer.

In line with the other LMDh chassis, its bodywork features key styling cues from the brand's road car range. The technology in the ICE element of its twin-turbo V8 hybrid powertrain, however, will be transferred directly from its inline four-cylinder 1.6-litre turbo used in the Hyundai i20 N Rally 1 car.

This decision was dictated by the short timeline for the Genesis LMDh project. "We can say that the pistons, the cylinder liners, conrods, the combustion chamber and all the valvetrain is a one-to-one from the rally engine to the LMDh V8, but modified, of course," said Hyundai Motorsport tech director Francois-Xavier Demaison. "We will have to change the cylinder spacing, for example, but the main parts of the engine will be very similar just to avoid any issues."

Before Genesis Magma Racing competes in the FIA WEC for the first time, it will spend the 2025 season competing in the European Le Mans Series' LMP2 class with partner team IDEC Sport. This collaboration will allow Genesis' team members to get up to speed with ACO rules racing before joining the world championship.

Genesis Magma Racing has confirmed that it will run its endurance program from a base in the south of France at Circuit Paul Ricard, in close proximity to both ORECA and IDEC. RT

FROM WRC TO LE MANS
Page 44

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Formula E and Fortescue Zero ready to deliver fast charge races

FORMULA E's long-awaited fast charge pit stops are set to finally become a feature of races this season.

The concept was originally intended to accompany the introduction of the Gen3 car, two years ago. But with the technology still in its infancy, it has taken time to gain confidence in the safety and reliability of the system. Ultimately, Formula E turned to Fortescue Zero – a decarbonization expert that acquired the company originally known as WAE – to get the project over the line.

ABOVE Pitstops are returning to Formula E

The system, which goes under the working title 'Pit Boost', is likely to be used at double-header events, adding strategic variety to the second race. The new Gen3 Evo cars will receive a 10% battery recharge at 600 kW that will take approximately 30 seconds.

The concept was tested for the first time during a trial race at pre-season testing in Spain, with the data from that simulation outing analysed by the championship and governing body.

Fortescue's batteries and control systems have played an integral part in the electrification of motorsport. The company was also recently awarded A$10 million in funding from The Australian Renewable Energy Agency (ARENA) to develop a six megawatt (MW) fast charger test unit to support the company's innovative fast charger technology. The project involves building, testing and validating multiple test unit chargers with the aim to deploy the first production 6MW charger by the end of 2025.

The 6MW fast charger will be compatible with a wide range of battery electric heavy mining equipment and designed to meet all operational requirements. The company's intention is to roll out around 250 fast chargers of varying capacities across its iron ore operations before the end of the decade. RT

Maserati commits to Gen4 era

MASERATI has committed to an additional four years in the ABB FIA Formula E World Championship as a manufacturer, securing its participation in the Gen4 era.

With a rich legacy spanning over a decade, Stellantis Motorsport has been at the forefront of developing high-efficiency powertrains for Formula E brands DS and Maserati MSG Racing throughout Gen3 and into the Gen3 Evo era.

Since joining Formula E two years ago, Maserati has achieved six podiums, two pole positions and two race wins. In the process, the Modena-based squad notched its first world championship single-seater win since Juan-Manuel Fangio's legendary win at the Nürburgring in 1957.

Jeff Dodds, Formula E's Chief Executive Officer, said: "Maserati have both been a valuable part of our championship, and have demonstrated remarkable performances on track, while driving forward electric vehicle technology that benefits everyday road users.

"Their ongoing involvement alongside other global OEMs such as Nissan, Jaguar, Porsche and Lola, is a testament to Formula E's status as a competitive and relevant platform for the future of electric mobility."

LEFT Maserati has extended its involvement until at least 2030

Santo Ficili, Chief Executive Officer, Maserati, commented: "For this brand, the bond between the track and the road is unbreakable and the evolution of the single-seaters shows how many possibilities for development electric mobility holds.

"We will continue to draw major developments from the races in the ABB FIA Formula E World Championship, to transfer them into our 100% electric range that now consists of the Grecale Folgore SUV, the iconic GranTurismo Folgore and the GranCabrio Folgore convertible."

Maserati becomes the fifth manufacturer to sign up to Formula E's Gen4 chapter, alongside Porsche, Nissan, Jaguar and Lola.

The Gen4 Formula E era begins in Season 13 (2026/27) with a brand-new car hitting the track. It promises regeneration capacity of up to 700 kW, increased power output of up to 600 kW, and further safety enhancements. RT

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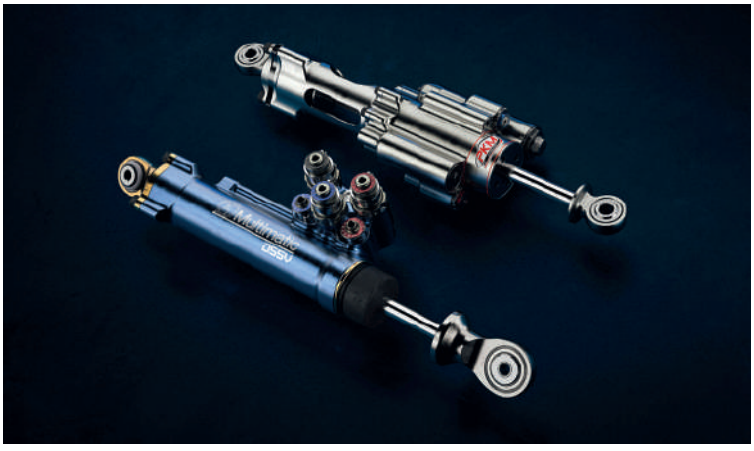
Multimatic acquires leading racing damper supplier

MULTIMATIC is to acquire a majority stake in PKM Consulting, a leading supplier of racing dampers across multiple motorsport disciplines.

PKM Consulting is joining Multimatic as an autonomous division of its Special Vehicle Operations Group. It will become responsible for all racing damper operations by 2027, with full support from Multimatic and complete access to its resources, innovation, and expertise.

To aid the transition, PKM Consulting's three founding partners will remain on the management team. Thierry Gravier has been appointed General Manager, with Paul-Etienne Berthe and Emmanuel Pereira fulfilling the roles of Assistant General Managers.

"We are incredibly pleased to join forces with PKM Consulting to expand the knowledge base and operational footprint of our racing damper business," said Pascal Zurlinden, Vice President Operations of the Multimatic Special Vehicle Operations Group. "As family-owned and operated organizations, we are fully dedicated to the long-term success of our customers competing around the world. This agreement significantly elevates our ability to achieve this goal through the tremendous expertise of talented individuals from both companies, as well as our combined operational capabilities."



BELOW PKM will become Multimatic's dedicated racing damper division

Founded in 2008, PKM Consulting started as a motorsport consulting company to assist teams and manufacturers in optimizing vehicle dynamics performance, based in Signes, France, close to the Paul Ricard racetrack. In response to increasing demand, the company began producing its own successful range of racing dampers. PKM Consulting's customer results over the last decade include success in the World Rally Championship, the 24 Hours of Le Mans and the Pikes Peak Hill Climb. The company has also become a leader in other areas of motorsport, including highly innovative hydraulic jacks for rallying and other hydraulic systems for race cars.

"I am excited to start the next chapter in PKM Consulting's legacy. Our access to Multimatic's extensive resources and expertise will greatly benefit every single one of our customers," said Thierry Gravier, President of PKM Consulting.

"There will be no disruption to our operations and services. We look forward to mapping out the future strategy of racing damper technologies with the tremendously talented team at Multimatic!"

The acquisition enables Multimatic to service manufacturers and privateer teams through a dedicated racing damper division via PKM Consulting, without compromising the growing demand of spool valve dampers for production vehicle applications. RT

Hyundai Elantra N1 TC Evo launched

HYUNDAI Motor America (HMA) has unveiled its new Elantra N1 TC Evo race car.

This evolutionary model will be the newest contender in SRO's Touring Car (TC) America series, beginning in 2025. It will make its racing debut at the TC America series opener this March at Sonoma Raceway as Hyundai seeks to defend the 2024 TC Drivers', Teams' and Manufacturers' crowns.

The car's updated exterior is based on the global ELANTRA N1 Cup Car, which participates in Korea's Hyundai N Festival one-make series and the Hyundai N Cup in China. The vehicle includes new, wide fenders and 18x10-inch wheels, and is further enhanced to meet SRO TC Series homologation requirements. The car features a Type 2.0-litre, inline four-cylinder/single turbo, direct injection powerplant.

ABOVE The Elantra N1 TC Evo racecar was launched at Sonoma Raceway

"TC America remains a crucial step on Hyundai's motorsports ladder, offering an affordable gateway to highly competitive road racing on some of the most renowned tracks in the U.S.," said Joon Park, Vice President of N Brand Management Group at Hyundai Motor Company. "The Elantra N1 TC Evo offers the perfect foundation to build on the success of its predecessor."

Additionally, Hyundai will host the new Hyundai N Trophy Cup, a championship within a championship, which will be part of the TC America Series. RT

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Extreme H headlines Autosport Engineering 2025

THE new Extreme H hydrogen-powered off-road series will top the bill as motorsport's finest technical companies gather once again at Birmingham's NEC this month for the 2025 Autosport Engineering show.

The two-day event will showcase engineering excellence on January 9-10, as a key component of the wider four-day Autosport International show. And for the first time, major exhibitors at Autosport Engineering will be featured on the Autosport main stage to offer revealing insights into their innovations and technologies.

Extreme H, the new series which launches in 2025, will take to the stage on Friday January 10th at 11am, with Mark Grain, Technical Director at Extreme E, offering a vision of how motorsport can accelerate hydrogen technologies.

Extreme H will continue the revolutionary steps set by its electric-powered predecessor Extreme E, combining exciting racing with a strong commitment to sustainability as the first motorsport series to be powered by hydrogen.

The championship's Pioneer 25 buggy will be powered by French specialist Symbio's 75 kW hydrogen fuel cell, replacing the battery that was used as the principal energy source in Extreme E. The hydrogen fuel cell powers a battery pack that is produced and supported trackside by Fortescue Zero.

The Symbio StackPack 75 fuel cell has been pushed to the limits during intensive testing. Over the past 12 months of development, the car has completed as many test miles as three seasons of Extreme E.

The Pioneer 25's peak output of 400 kW (550 bhp) ensures it can accelerate from 0-100 kph in just 4.5 seconds and tackle gradients of up to 130 per cent.

Hesketh

Beyond the activities on the stage, trade visitors to the Engineering Hall on Thursday and Friday can see James Hunt's Hesketh which won the 1975 Dutch Grand Prix, Hesketh's only World Championship Grand Prix victory. And look out for the rare Maki F1 car, one of the many during the 1970s to be powered by the legendary Cosworth DFV V8 engine and raced by Japanese team Maki Engineering.

Companies both familiar and new to the show will exhibit their specialities. Those returning include Willans, Westwood Cylinders and Wavetrac, while established brands such as Arrow Precision Engineering, ARP, Link Engine Management, Raceparts and R53 Suspension will also appear.

ABOVE Extreme H tops the bill in the ASI engineering section

A mix of overseas companies will add an international flavour to the event, with Öhlins, Samsonas, Askubal and SDT Brakes among those travelling to the Birmingham venue. Meanwhile, first-time exhibitors include Haltech, Premier Fuel Systems and Servotest Systems.

The 2025 show also boasts a good uptake in interest from trade federations such as AMUK and the GTMA. AMUK members that will feature include Nikken, AMufacture and Matsuura, while GTMA members Vision Engineering, Voestalpine, and Knoll will also be present at the trade-only show.

A special anniversary grid, marking 75 years of Formula 1, will be the centrepiece of the main motorsport exhibition. The attraction will feature a world championship-winning 1990s Williams often described as the most technically sophisticated F1 car of all-time. The Williams FW15C of 1993 was the car in which Alain Prost claimed his fourth F1 world championship in what turned out to be his final season as a grand prix driver.

Designed by Patrick Head and Adrian Newey, it was also the last of F1's most high-tech generation of cars before the FIA banned electronic driver aids for 1994. The FW15C bristled with so-called 'gizmos', incorporating anti-lock brakes, traction control, active suspension, semi-automatic and fully automatic gearbox options. RT

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NASCAR extends Stratasys partnership

NASCAR has expanded its long-term technical partnership with Stratasys, making the company its official 3D printing partner.

A new state-of-the-art 3D printing lab is set to open at the NASCAR Research & Development Center in Concord, North Carolina. The facility features multiple Stratasys technologies, including F370, 450mc, F900 (FDM printers) and a NEO800 (SL printer) to support research and development, parts production and tooling for NASCAR's three national series.

"Partnering with Stratasys allows NASCAR to push the boundaries of performance and accuracy like never before," said John Probst, executive vice president, chief racing development officer at NASCAR. "Their 3D printing technology empowers us to quickly iterate and optimize components."

Stratasys will increase the existing FDM (Fused Deposition Modelling) capabilities within the NASCAR R&D centre, allowing for larger-scale part production, and NASCAR will also integrate Stratasys NEO stereolithography (SL). These technologies will support a variety of applications, from aerodynamic testing to prototyping and production.

"Our partnership with NASCAR allows Stratasys to showcase the unique advantages of 3D printing in motorsports," said Rich Garrity, chief business unit officer at Stratasys. "From on-demand manufacturing of custom components to speeding up the design cycle, we're helping NASCAR with faster production times and enhanced part performance. Furthermore, our work in high-performance environments like NASCAR spurs innovation in the production of commercial vehicles, demonstrating the broader impact of additive manufacturing across the automotive industry." RT

BELOW Every NASCAR currently uses 3D printed parts

Q&A

Andy Berry, Managing Director of Global Logistics Management

Congratulations Andy, Global Logistics Management was recently awarded a Motorsport Industry Association 'Business Excellence Award'. How does it feel to be an award winner?

"Thanks. We are really proud and privileged to be a winner. We've been working with the MIA and its members for a while now and it's great for our team to be recognised for their efforts."

What can you tell us about the work leading up to the award?

"It's mainly around compliance. We found that a couple of our UK clients were struggling with some of the regulations around international trade, particularly on imports. We have a lot of knowledge in these areas gained over the years but realised that for our clients it wasn't something they were always comfortable with, day to day.

"Things like IPR, RGR and PVA are not always easy to understand or manage when you are busy manufacturing high-performance equipment.

"We set up a method to harvest import and export data and built databases to analyse the flow of goods. We used that data to build audit packs that worked for HM customs in the UK and spent some time with customs officials refining the process."

So this is in consultation with UK customs?

"Exactly, HMRC in the UK are very keen to support UK business and have been really helpful with advice and support. With their guidance we've been able to help our clients deliver on their obligations and let them get on with running their businesses."

And how does the MIA fit into this?

"We've been members of the MIA for close to 15 years and they do a great job of giving a voice to the hundreds of UK companies who work in the motorsport business. We offered to help their members with an advice service based on the work we'd done for some of our clients. If we can help an MIA member by sharing our knowledge, then that can only be a good thing."

Thanks Andy, congratulations again.

"Thank you." RT

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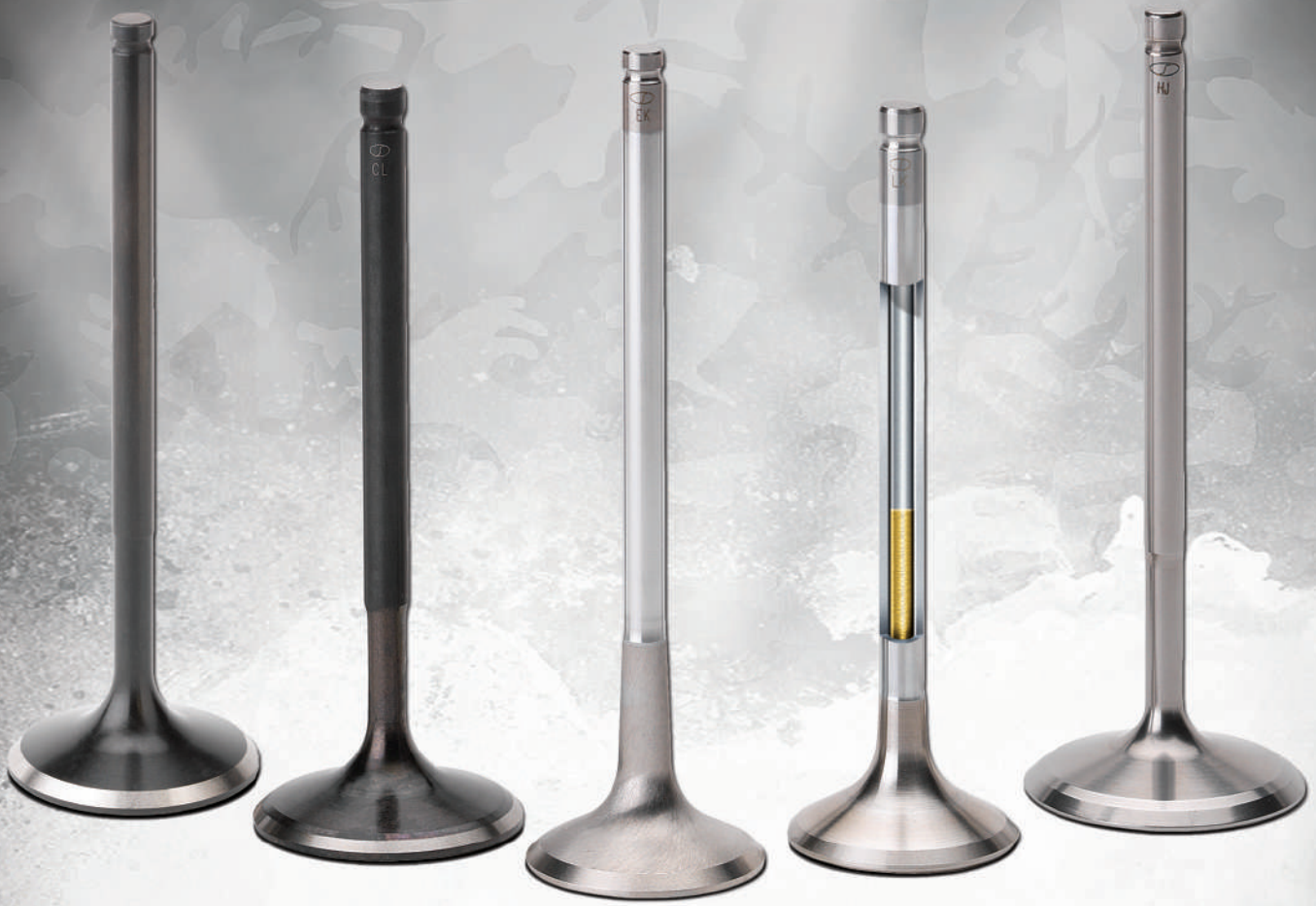

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PASCAL VASSELON
Vice President TGR Strategic Motorsport Development

"The WMS has become a yearly 'Must Attend' event. The now-usual presence of many motorsport leaders, and especially of the governing bodies, make the discussions go beyond just interest: they can really influence the future of our sport. It is now more important than ever to call upon the brightest minds there to design a path toward the necessary energy transition. Long life to the WMS!"

MARK SIBLA
Vice President and Chief of Staff, IndyCar

"Each year, the World Motorsport Symposium brings together a distinguished group of racing experts, each of which is an impactful leader in their field. Their knowledge, insight and transparency on the critical challenges and vision of motorsport make this event essential for industry professionals."

BERNARD NICLOT
ACO's Mission H24 Innovation Director

"The Automotive World is, with each passing year, more and more difficult to predict. The target is well known: Zero CO2; but the way to achieve it on a large scale is dramatically challenging. In such a period, the World Motorsport Symposium, being so open-minded, is very valuable to share and challenge ideas and solutions not just for motorsport, but for motorsport as a lab for future road mobility."

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DR VALERIA LORETI
Delivery Manager Motorsport, Fuels Technology Group, Shell Global Solutions (Deutschland) GmbH

"Participating in WMS 2024 was not only a great opportunity to hear directly from technical experts on a number of relevant and stimulating topics, but also the opportunity for networking and establishing those key relationships that are the basis for further development and exciting breakthrough steps."

DAVID SALTERS
President of Honda Racing Corporation USA (HRC US)

"I really appreciate the effort that goes into the Symposium, the straightforward open discussion, informed debate and reflection."

ERIC JACUZZI
Vice President, Vehicle Performance at NASCAR

"Another great learning experience for the two of us that attended from NASCAR. The topics were very relevant to the future of motorsport, and challenged us to look deeper into some areas of development that we had not previously considered or perhaps considered seriously enough. As always, the collegial atmosphere and lively debates and conversations make for a great event. I am looking forward to seeing everyone again next year and hearing about the advancements another year brings."

ULRICH BARETZKY
Former Director, Audi Motorsport Engine Development, Audi AG

"The 2024 WMS in the famous Royal Automobile Club was very special, a real highlight to mark the event's 20th anniversary. The quality of presentations, as well as the respective discussions in this very special atmosphere, really makes me look forward to the 2025 event."

ALAN PATTERSON
Founder, BeyondMath

"WMS is the one event that brings together all the leaders in motorsport under one roof. As a startup, this is invaluable for us."

SERGE GRISIN
Motorsport Director, Symbio

"I was truly impressed by the quality of the discussions, the insightful exchanges with leading experts in motorsport and technology, the spirit of openness and constructive dialogue, and the overall sense of shaping not only the future of motorsport but also, and more importantly, the future of mobility. A future that aspires to be more sustainable."

INNOVATION RISES FROM THE ASHES

The biggest fibre innovation in 50 years is about to revolutionise safety standards in Formula 1. By **Chris Pickering**

IT'S easy to forget just how deadly motor racing once was. But Romain Grosjean's crash at Bahrain in 2020 was a grisly flashback to the days when Formula 1 drivers took their lives in their hands.

Grosjean's rear wheel clipped the front of Daniil Kvyat's Alpha Tauri at 150 mph, sending the Frenchman's Haas spearing into the barriers on the outside of Turn 3. He was still travelling at nearly 120 mph when the front of the car struck the barrier, resulting in an impact of 67G, which ripped the car in two.

The Halo device – adopted two years previously – undoubtedly saved Grosjean's life as the front of the car embedded itself into the barriers like an arrowhead. But he wasn't out of the woods yet. The fuel tank inspection hatch and the engine's fuel line were ripped off during the impact, covering the survival cell with fuel, which promptly ignited.

Grosjean's left foot was trapped and it was only by pulling it out of his boot that he was able to escape after 27 seconds in the heart of the inferno.

It's testament to how far motorsport safety has advanced – both on and off the track – that Grosjean was able to drag himself out of the wreckage.

The Haas, its carbon fibre monocoque and its fuel system had performed as well as could be expected during such a brutal impact. Nonetheless, fuel cell provider ATL undertook a detailed investigation, which has led to the development of an innovative new fuel tank technology in collaboration with chemical giant DuPont.

"When the chassis failed [on Grosjean's

Images Courtesy of F1

ABOVE & RIGHT The world held its breath for 27 seconds as Romain Grosjean struggled to emerge from the fireball. The incident has led to the use of revolutionary new technology in F1 fuel systems

car], the QD fitting was pulled out of the bag like a Rawlplug being ripped out of a wall," comments ATL's CEO Giles Dawson. "There's no way the bag would have survived, as it was effectively welded solid to the engine. But we took our findings to the FIA and they invited us to come and examine the remains of the car, which led to a series of conversations around the new FIA safety standards."

While there was nothing that would have prevented the damage to the fuel system in Grosjean's accident, the work did highlight several challenges with the use of Kevlar in motorsport fuel tanks. It's known to be a tricky material to bond, and this challenge increases both with temperature and with the use of aggressive fuel chemistries.

"We did some work with the FIA immediately after ▶

the accident on the effects of temperature on the material strength," Dawson recalls. "At the time, the standard just specified 'ambient temperature', but the temperatures in an F1 fuel tank can reach 60 deg C by the end of the race. Some teams have gone even hotter in the past and we've helped them to improve the chassis insulation, but ultimately what we've been striving to do is find a material that's as strong as it can be at those elevated temperatures."

But the problem doesn't come down to temperature alone. Specifically, it was the combination of elevated temperatures and ethanol-rich fuel used in Formula 1.

"We knew through the compatibility studies we'd been doing over the past decade that the wet properties of the material were getting more and more challenging," Dawson explains. "The dry properties have remained excellent, but fuel cell manufacturers across the industry were seeing a reduction in the coating adhesion of the fabric when combined with new fuels."

ABOVE It's not only the bladder material that needs to be flexible: the more complex the bladder, the more flexible ATL's technicians need to become during the production process!

Wonder material

While this work was taking place, ATL became aware of a new aramid fibre material that DuPont was developing primarily for body armour. Known as Kevlar EXO, it's been described as the biggest leap forward in ballistic materials since Kevlar was developed in the 1960s by DuPont chemist Stephanie Kwolek.

Among the new material's benefits are an improvement of around 30 per cent in the strength of its raw fibres. Combined with a special polymer developed in-house by ATL, this

RIGHT ATL's new design uses Kevlar EXO fibres with a bespoke weave pattern co-developed with DuPont. The chemicals giant worked for over a decade to develop Kevlar EXO, a completely reimagined, next-generation aramid fibre

> *"Not all of the synthetic blends are more aggressive, but some of them are really quite a lot more challenging than traditional fuels"*

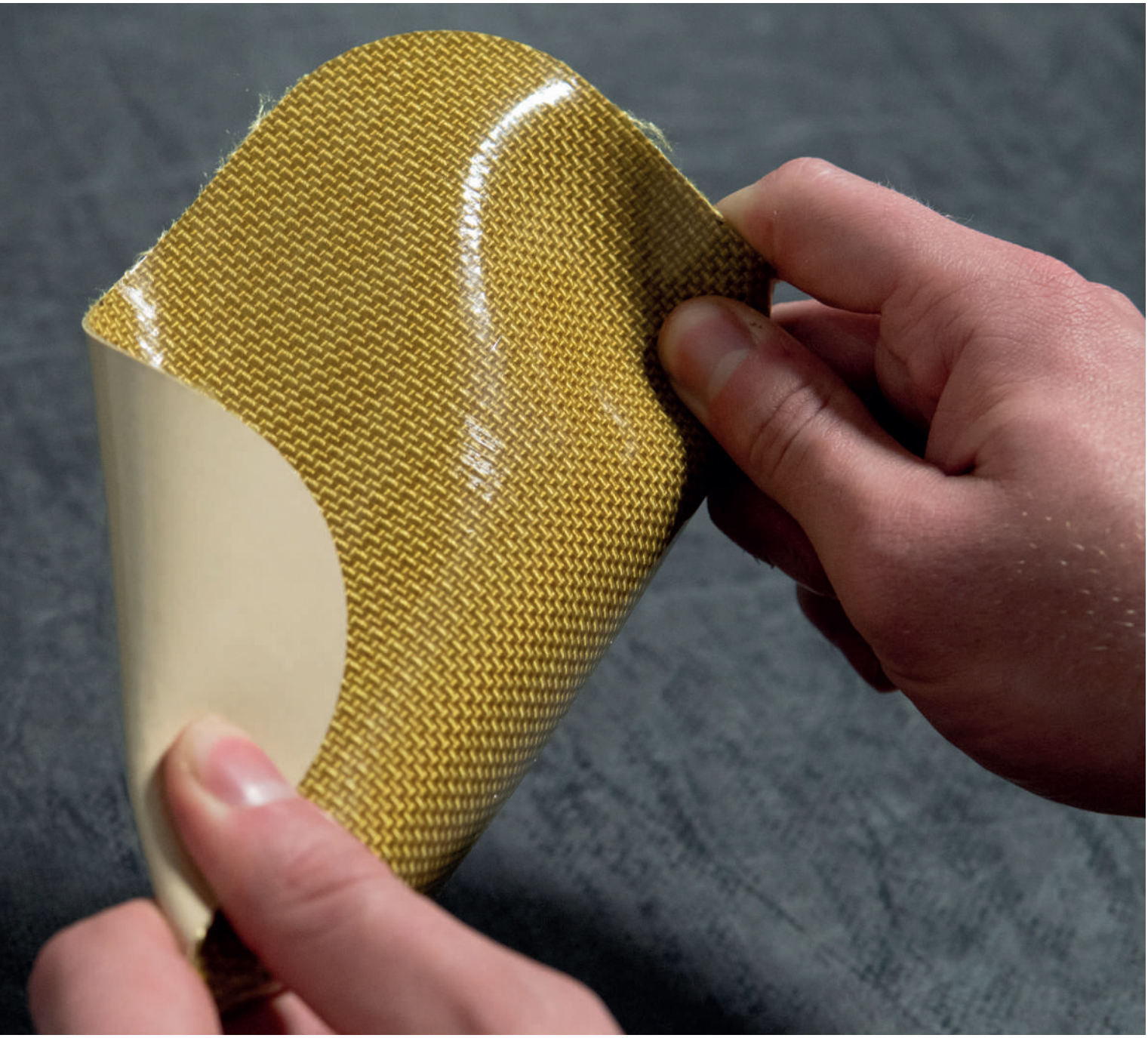
translates into material that's some 22 per cent lighter than the company's current FT5 benchmark. Crucially, it's also compatible with a far wider range of fuels.

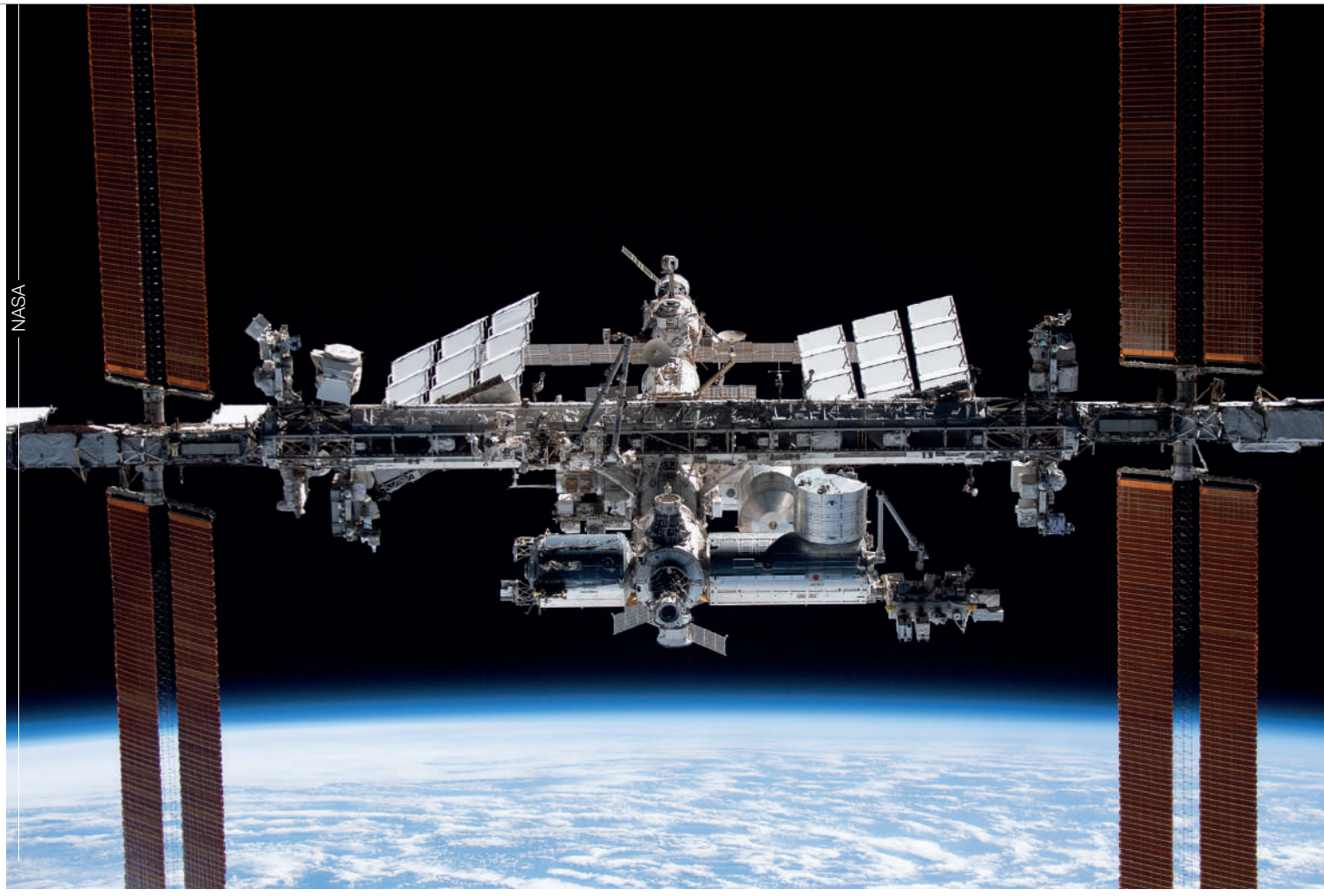
"We spoke to the teams in 2021 and said, 'If we could give you three things, what would they be?' The feedback we got was that they wanted the tanks to be lighter, more flexible and capable of operating over a wider temperature range," recalls Dawson.

The Kevlar EXO fibres deal directly with the first two points. Formula 1 fuel cells are created using a woven fabric core, which provides the tank with its puncture resistance and tensile strength. Traditionally this would be Kevlar or ballistic Nylon, but ATL's new design uses Kevlar EXO fibres with a bespoke weave pattern co-developed with DuPont.

The polymer coating is applied to both sides of the fabric core, effectively establishing two separate membranes for a double skin. The clever bit, explains Dawson, lies not just with those two materials, but how you bond them together.

"Ultimately, it's a laminate construction, and it's the bonding [between the core ▶




NASA

and the polymer] where we've found the issue with some of the more aggressive fuels," he says. "Not all of the synthetic blends are more aggressive, but some of them are really quite a lot more challenging than traditional fuels."

The outright temperature limit is dictated by the polymer, which remains the same as the old designs. However, the new laminate is said to behave more consistently at elevated temperatures.

"We're not able to shift the peak temperature from 60 deg C to 80 deg C, but what we can do is ensure that it's stronger than the old material at, say, 45 deg C," notes Dawson.

Space invader

ATL celebrates 40 years as the sole fuel tank supplier to the F1 grid this year. The series has seen a lot of changes during that time, with more to come next year when the 2026 regulations take effect.

The new regulations are expected to impact the fuel tank in a number of different ways. Firstly, it seems inevitable that the shape of the tank will change. The space is already heavily constrained – by the rear face of the driver's safety cell to the front, the engine at the rear, the radiators to the sides, the air intake snorkel above, and the battery for the hybrid system below. It's thought that the total fuel volume will remain the same, but the bigger battery for the 2026 hybrid will intrude further into the space currently occupied by the tank.

Inside a Formula 1 fuel tank there are a series of horizontal baffles to prevent fuel surge. These are equipped with flap valves that allow the fuel to drain downwards but don't allow it to surge upwards, keeping the centre of gravity as low as possible. Typically there are then two fuel pumps – each feeding from a different ▶

ABOVE Kevlar EXO is to be trialled at the International Space Station, where every gram counts and the risk of collision with space debris, which can be travelling up to 5.4 km per second, is an ever-increasing threat

BELOW ATL's UK manufacturing facility in Milton Keynes

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part of the tank – going to a central collector where the main fuel pump feeds the engine.

"The tanks are roughly pyramid shaped – tapering towards the top – and currently they tend to completely envelop the top of the battery, leading to quite a complex shape at the base of the tank," explains Dawson. "I think it's likely that the larger battery will extend to the full length of the tank, so you'll end up with a saddle arrangement with pontoons either side of the battery. That on its own would partition the tank to a certain extent, and I think it could change the scavenging concepts significantly."

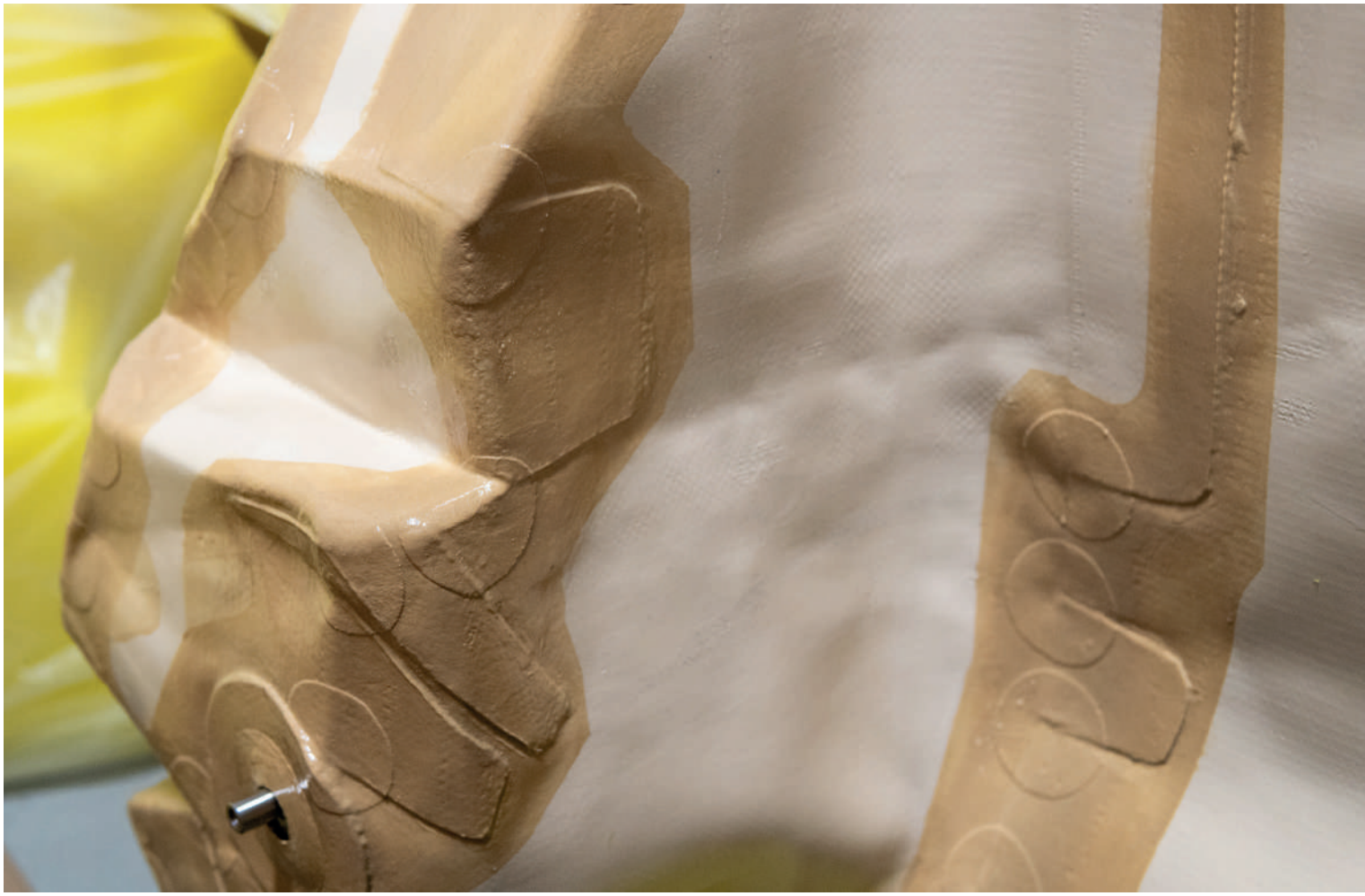
> *"We spoke to the teams and said, 'If we could give you three things, what would they be?'"*

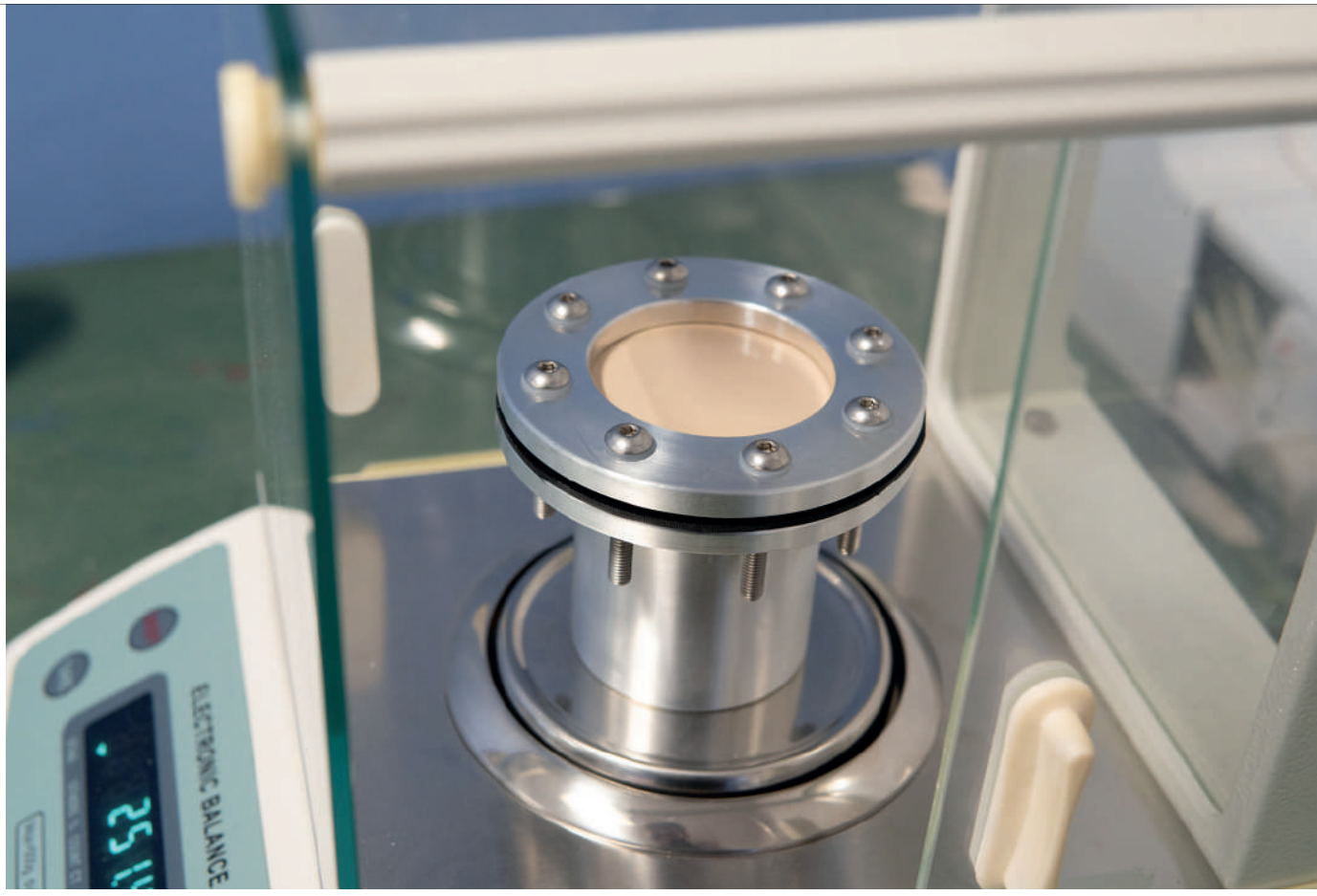
A question mark still hangs over the temperature of the fuel tank with the new regulations. The presence of a larger battery could well result in more heat soak. ATL is investigating options that could potentially increase the safe temperature range of the tank, but there's no imminent solution, says Dawson.

"We're lucky in a way that we get to define the operating parameters for our product and it's up to the teams to stay within those," he comments. "The first thing we ask for if anyone encounters any reliability issues is the data for fuel temperature and pressure, and there's been more focus around that

Getty Images/NASCAR

ABOVE The learnings from the project could be applied to the likes of NASCAR, where rough racing on speedways puts safety in the spotlight





ABOVE The bladder materials undergo a multitude of tests, one being fuel permeation. Here the 'cup' is being weighed

RIGHT ATL's in-house capabilities include a full machining and fabrication team. Most of the ancillary components, such as the fill plate seen here, are made in-house and undergo their own set of inspection procedures to ensure accuracy and quality

LEFT While the original fibre was a para-aramid material composed of two monomers, Kevlar EXO is a copolymer with an additional monomer. This additional monomer enhances molecular alignment within the fibre

since Grosjean's accident. The outgoing regulations, for instance, didn't specify a maximum pressure for the tank. In theory, you could have a tank full of fuel pressurised to 10 bar.

"So we asked the FIA to write in a regulation that says we will do a test at proof pressure. For example, if the teams are running at one bar, we will test the tank at one bar in a dummy chassis to verify that all the parts that the teams have provided for use in the tank are safe."

Another aspect that may change with the increased level of hybridisation in the 2026 rules is the vibration characteristics of the car. ATL has already been looking into vibration from various different sources under the current regulations, and plans to feed this knowledge into the new Kevlar EXO tanks.

"We started to notice some strange things happening in Qatar last year – behaviour we didn't understand, things we'd never seen before, and that drove a lot of R&D work," explains Dawson. "That caused us to pause things briefly with the development of the new material so we could really understand what was happening and how it might impact things."

Vibration frequencies

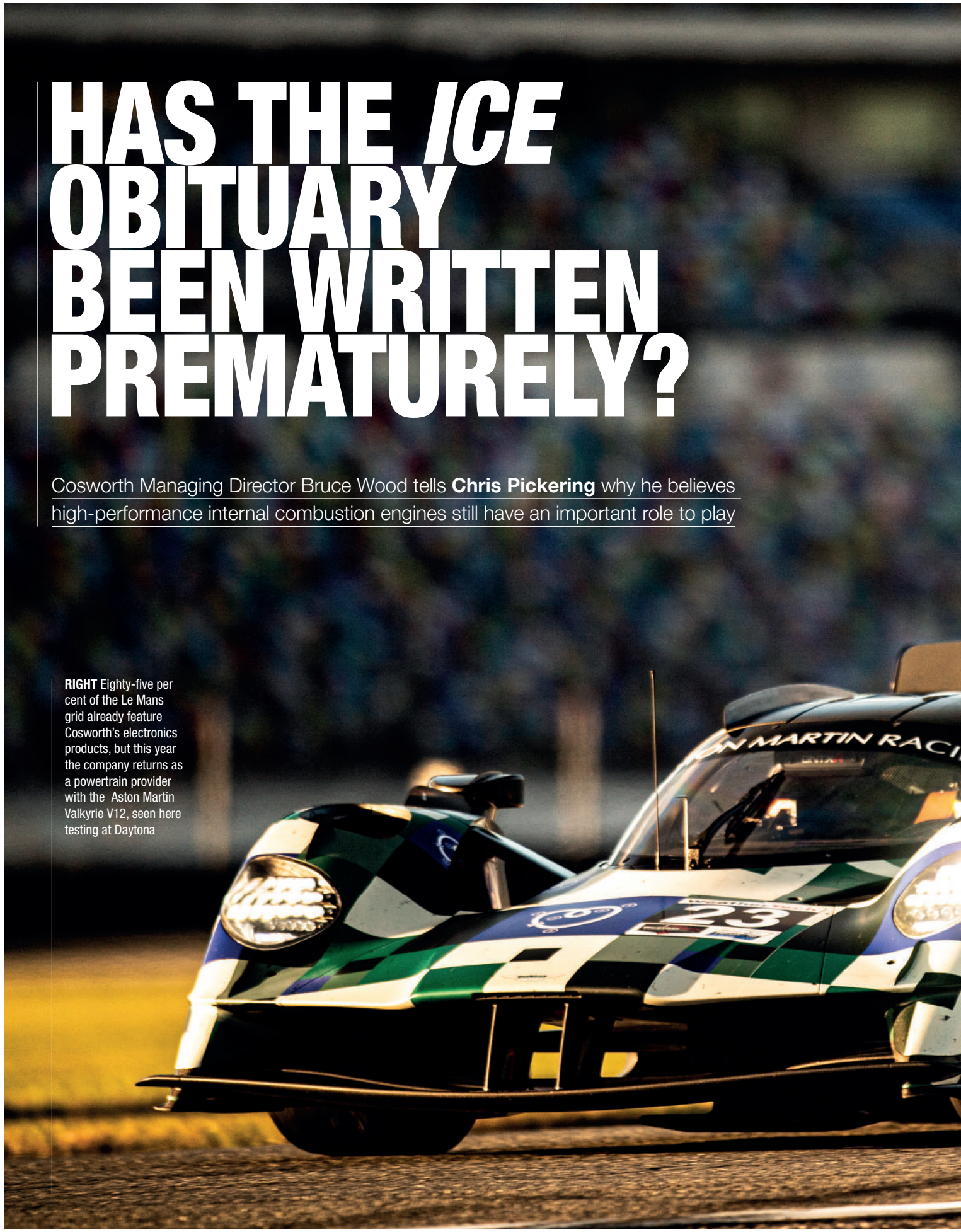
The issue was soon traced to vibration frequencies that hadn't been seen before. Although Dawson doesn't elaborate on exactly what caused them, it may not be a coincidence that they occurred at Qatar – a track known for its abrupt kerbs, which caused well-documented tyre issues in 2023 before being re-profiled for 2024. Nonetheless, ATL will also be keeping a watchful eye out for any changes brought on by the new cars themselves.

It's this process of constant evaluation and improvement that has kept the company at the top of its game, Dawson believes.

"I'm very proud of what we've achieved and I'm also very proud that DuPont chose to work so closely with us on this project," he comments. "They're a huge company and we're a small, specialist supplier, so for us to be their flagship on a new product like this is a real honour." RT

HAS THE *ICE* OBITUARY BEEN WRITTEN PREMATURELY?

Cosworth Managing Director Bruce Wood tells **Chris Pickering** why he believes high-performance internal combustion engines still have an important role to play



RIGHT Eighty-five per cent of the Le Mans grid already feature Cosworth's electronics products, but this year the company returns as a powertrain provider with the Aston Martin Valkyrie V12, seen here testing at Daytona

WHAT does the future hold for the internal combustion engine? It's one of the most vexing questions in the automotive industry. Environmental concerns, politics and practical considerations are locked in a tumbling vortex that seems to lack any clear consensus.

But does that really matter to motorsport? Road cars face fundamentally different challenges, with cost, convenience and regulatory compliance sitting at the top of the agenda for most manufacturers. Motorsport, on the other hand, is about delivering a spectacle for the fans and the drivers. There's an argument that we could sever the already-tenuous links with road car technology and allow motorsport to forge its own path, complete with rumbling V8s and soaring V12s.

It's a debate that's raged longer than you might think.

"Road relevance is something that came up when Formula 1 switched from the V10s to the V8s, and again when it went to turbocharged V6s," notes Bruce Wood, managing director of Cosworth. A veteran of some 38 years with the Northamptonshire firm, he's seen Cosworth evolve through motorsport stardom and road car partnerships, to a hypercar engine manufacturer and now (indirectly) back into motorsport.

"The current Formula 1 engines sit right at the pinnacle of thermal efficiency for an internal combustion engine, but there's not much theatre compared to the high-revving V10s or the turbocharged 1.5-litre cars," he says. "The question remains: Does motorsport want to be the pinnacle of technology that can be transferred into road cars or is it really more about theatre?"

It's not a question to which he professes to know the answer, but there are some signs that the balance is tipping progressively towards the entertainment side.

"I think what we've seen with [series owner] Liberty Media, the new races in F1 like Las Vegas and the Netflix series *Drive to Survive* is that it's at least as much about entertainment as it is about technology," comments Wood. "Hypothetically, if combustion engines were reduced to a relatively small part in the road car market, I don't personally think it would matter if Formula 1 or another top series wanted to continue using them."

ICE vs BEV

There's certainly no great environmental imperative. A number of series have already switched to fully sustainable fuels – with Formula 1 set to join them in 2026. Theoretically, these fuels can be completely carbon neutral, which raises the tantalising prospect that an internal combustion engine could actually offer lower lifecycle CO2 than an electric powertrain, due to the emissions attached to battery production.

The jury is still out on whether sustainable fuels could be a mainstream ▶

LAT Images/IMSA

Getty Images/Red Bull Content Pool

solution for road cars. At present, these fuels are simply too scarce and too expensive to compete with battery electric vehicles on total cost of ownership. But in motorsport, where mileage is relatively low, fuel is a far smaller percentage of the cost, and teams are already used to working with specialist suppliers, there are no such limitations.

Regulations

Budget is clearly a factor too. In theory, teams could run much simpler, cheaper engines if they abandoned the quest for efficiency, but Wood stresses that he's not suggesting that motorsport technology should regress. There again, the cost isn't necessarily defined by the technical regulations, he points out.

"A few years ago, we were approached by the FIA, who asked what sort of regulations would make us interested in coming back to Formula 1 as an independent engine supplier," he recalls. "Our feeling was that the attractiveness of the series to independent entries wasn't generally very much to do with the regulations, but the vast sums that the OEMs will spend to win the championship. You could be racing lawnmowers, and the costs would still spiral."

Nonetheless, there are some technologies that have the potential to drive higher costs, Wood concedes: "There's nothing in the internal combustion engine itself that would cause us any great concern, but the one thing that we did feel was a potential obstacle to entry was the heat energy recovery system. That's tens or hundreds of millions in investment to understand, and then there's all the setup and optimisation at the circuit; you'd be fine-tuning the heat energy recovery

LEFT Wood believes F1's direction under Liberty Media, leaning more towards entertainment with events like Vegas, bodes well for the continued use of the ICE

BELOW The race-optimised Valkyrie AMR-LMH will run with a modified version of the naturally aspirated engine originally produced for the Valkyrie road car, which in its standard form revs to 11,000 rpm and develops over 1,000 bhp. The power unit is being enhanced to incorporate the Balance of Performance requirements of the Hypercar class

corner by corner and driver by driver."

Ironically, part of the challenge comes back to road relevance. Electrically-assisted turbochargers are starting to make an impact in the road car market, but much of the technology around Formula 1-style heat energy recovery is quite esoteric, which means that the R&D exercise would have to start from scratch with limited opportunity to recover its costs in other markets. In particular, the software and controls aspect is said to require a lot of work.

There have been suggestions in the past that Formula 1 could move to a semi-spec engine, with the bottom end provided by an independent supplier like Cosworth, while the top end and the induction system are engineered by the individual OEMs, but Wood is very sceptical.

"If you go back several decades there were examples of OEMs in Formula 1 who were effectively badging an engine designed and manufactured by an external supplier, but I don't think we'll do that again. The kudos for the OEMs comes from winning with their own engine," he comments.

> *"In all the time I've been at Cosworth, I feel like we're at the top of our game right now"*

What would happen if you went to the other extreme and removed the majority of the technical constraints?

"I think we'd probably end up with a similar situation to aerodynamics in F1, where everyone rapidly gravitates towards the same sort of solution," says Wood. "In some respects, it's perhaps no bad thing that we have these constraints. I remember when Formula 1 started introducing things like mandatory bore sizes and minimum weight limits for engines and it seemed like an outrage to the engine builders at the time, but in hindsight it was probably quite sensible.

"The danger is that people have to follow the most effective solution that's around at the time, but then the following year, someone comes up with something different and they all have to follow that instead. You can end up spending a fortune. So, I think the sweet spot is to have a reasonably tight technical framework without turning it into a blueprint, but then with a cost cap on top."

WEC flexibility

Cosworth first gained widespread recognition through its Formula 1 programme in the 1960s, but it wasn't until the company's work with Ford on high performance road cars in the 1980s that it truly became a household name. Now, Cosworth is back in the spotlight for partnering with three of the most prestigious names in the hypercar world. It has recently developed the naturally aspirated V16 engine in the Bugatti Tourbillon, along with the V12s in Gordon Murray's 'T' cars and the Aston Martin Valkyrie.

The partnership with Aston Martin has also brought Cosworth back into topflight motorsport, through the Valkyrie LMH programme. This category takes a very different approach to the technologically-constrained world of Formula 1, allowing manufacturers virtually limitless freedom in the design configuration, providing the car can be made to meet the target performance window. It's a philosophy that works very well, Wood believes.

"The WEC has a really good track record of enabling manufacturers to bring their own USP to the party," he notes. "We saw that historically with Mazda racing ▶

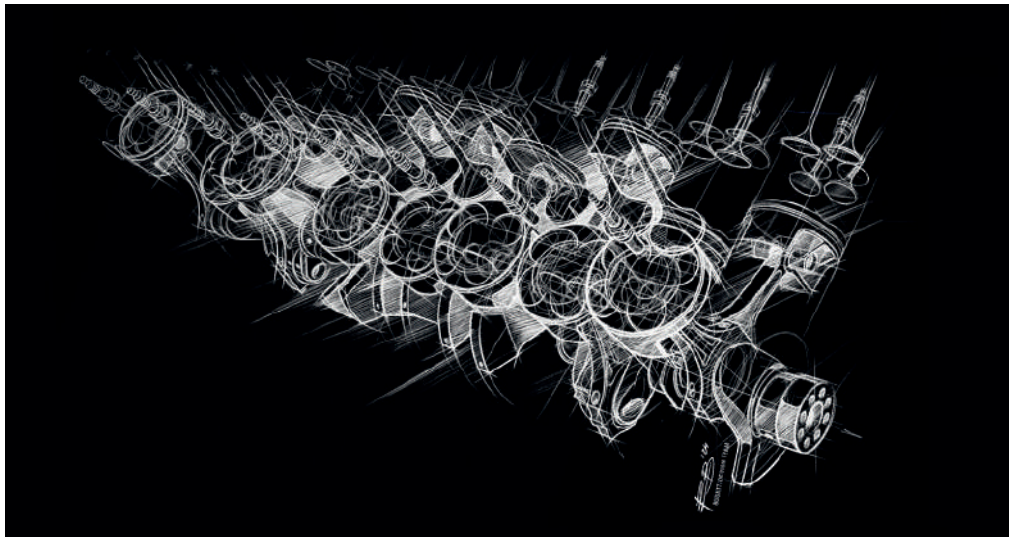
rotary engines and then four-cylinders, because that linked to their road cars. Audi and Peugeot when they were championing diesels and Aston Martin with the original V12s. And now with the V12 in the Valkyrie."

Few engines stir the emotion quite as much as a high-revving, naturally aspirated V12. It's one of the Valkyrie's standout points as a road car (in a market dominated by turbocharged V8s and V6s) and, as the only 12-cylinder car on the WEC grid, it promises to make the Valkyrie LMH an instant fan favourite. But it wouldn't perhaps be the first choice for a purpose-built racing car in a category that could easily be undertaken with half as many cylinders and far fewer moving parts.

More 'theatre' than F1

"It's thanks to the balance of performance that we can have such a wide range of different engine configurations in endurance racing," comments Wood. "It's not easy to precisely match the torque curve that's mandated, but it does enable people to rock up with a whole variety of different things without finding themselves at a ▶

RIGHT Cosworth won its last F1 title in 1994 with Michael Schumacher, when it developed Ford's Zetec-R V8 for Benetton



Bugatti

ABOVE & BELOW Cosworth has forged partnerships with some of the most prestigious names in the hypercar world, including the naturally aspirated V16 it developed for the Bugatti Tourbillon. With the crank and camshafts measuring almost a metre long, it had to employ innovative design to overcome the torsional loads

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disadvantage. I think the Hypercar regulations have definitely opened up an opportunity for engines that have a bit more theatre than those you'd find in Formula 1 at the moment."

Although the V12 in the Valkyrie LMH revs significantly slower than its road-going counterpart, Wood promises that it will still sound magnificent.

Beyond the numbers

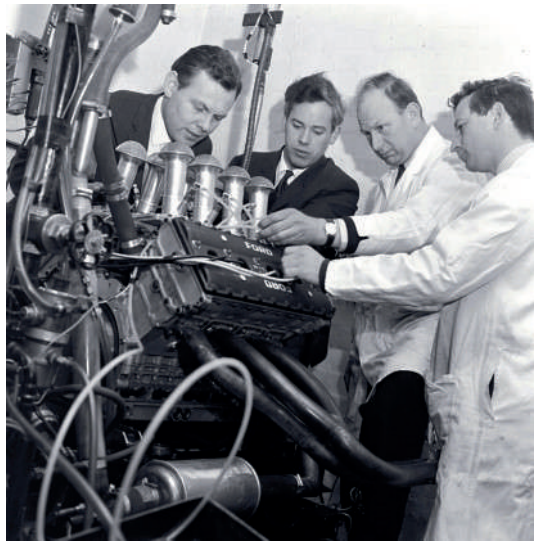
There's a slight irony to the inevitable comparisons drawn between the new road-going hypercar engines and the Formula 1 V12s of the early nineties, given that Cosworth never actually made one.

After a brief foray into turbocharged V6s to satisfy the new F1 regulations in 1986, the company returned to naturally aspirated V8s in 1988 – initially with a much-modified variant of the venerable DFV, known as the DFR. New designs soon followed – Michael Schumacher won his first World Championship with one in 1994 – but Cosworth stuck with V8s until switching to V10s in 1996.

"There are some similarities in the structural design to the high-revving V10s of that era – how you hold the gas pressure in and how you achieve bending stiffness and rigidity – but it's a fundamentally different design process with a modern road car engine," explains Wood.

Everything starts with emissions these days – even with a hypercar – he explains: "If you go back 20 years, particularly in racing, you would design an engine architecture based on how fast you wanted it to run, which would dictate your bore size and piston speed. And, to an extent, the question of how you put the fuel in came later.

ABOVE & RIGHT Cosworth recently won the RAC's coveted Dewar Trophy for the first time since 1969, when it had been recognised for the iconic DFV engine that revolutionised F1. Above, MD Bruce Wood (right) receives the award from RAC chairman Duncan Wiltshire; below, the original Cosworth DFV team of Bill Brown, Keith Duckworth, Mike Costin and Ben Rood



"Now, you design a combustion system in a single cylinder. Looking at how you're going to put the fuel in, how you can get the fuel and air to mix, what element of swirl or tumble you want, how you're going to ignite it, whether it's going to use a pre chamber and so on. You design that combustion chamber to meet the emissions requirements and then you clothe it in an engine."

If that's starting to sound a little dry and unemotional, the finished products are quite the opposite. Cosworth's hypercar clients are tapping into a niche that exists beyond horsepower figures and nought to 60 times. And they're not the only ones.

"The hypercar end of the market has almost nothing to do with transport. We describe it as wheeled luxury goods," comments Wood. "And in ▶

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that luxury space, people are very much buying for the emotion of it. I think that's why it's pretty hard to sell an all-electric hypercar. The thing that really drives the emotion is the noise and the heat and the smell that you get from an internal combustion engine. Not to mention the appearance. We work very hard to make these engines works of art. That's very difficult to do that with a battery, a motor and some orange cables."

Cosworth's background in Formula 1, where secrets are carefully guarded, has developed a culture of self-sufficiency within the business. It still has two large machine shops, 10 dyno cells and its piston forge on-site. For a time, post-Formula 1, the company was struggling to fill these facilities to capacity, but the hypercar projects mean that they are buzzing once again. At the same time, it's given the firm's customers a ready-made production partner with cutting edge facilities and a huge amount of experience.

"In all the time I've been at Cosworth, I feel like we're at the top of our game right now – both in terms of what we're delivering technically and the sweet spot that we're in commercially," notes Wood.

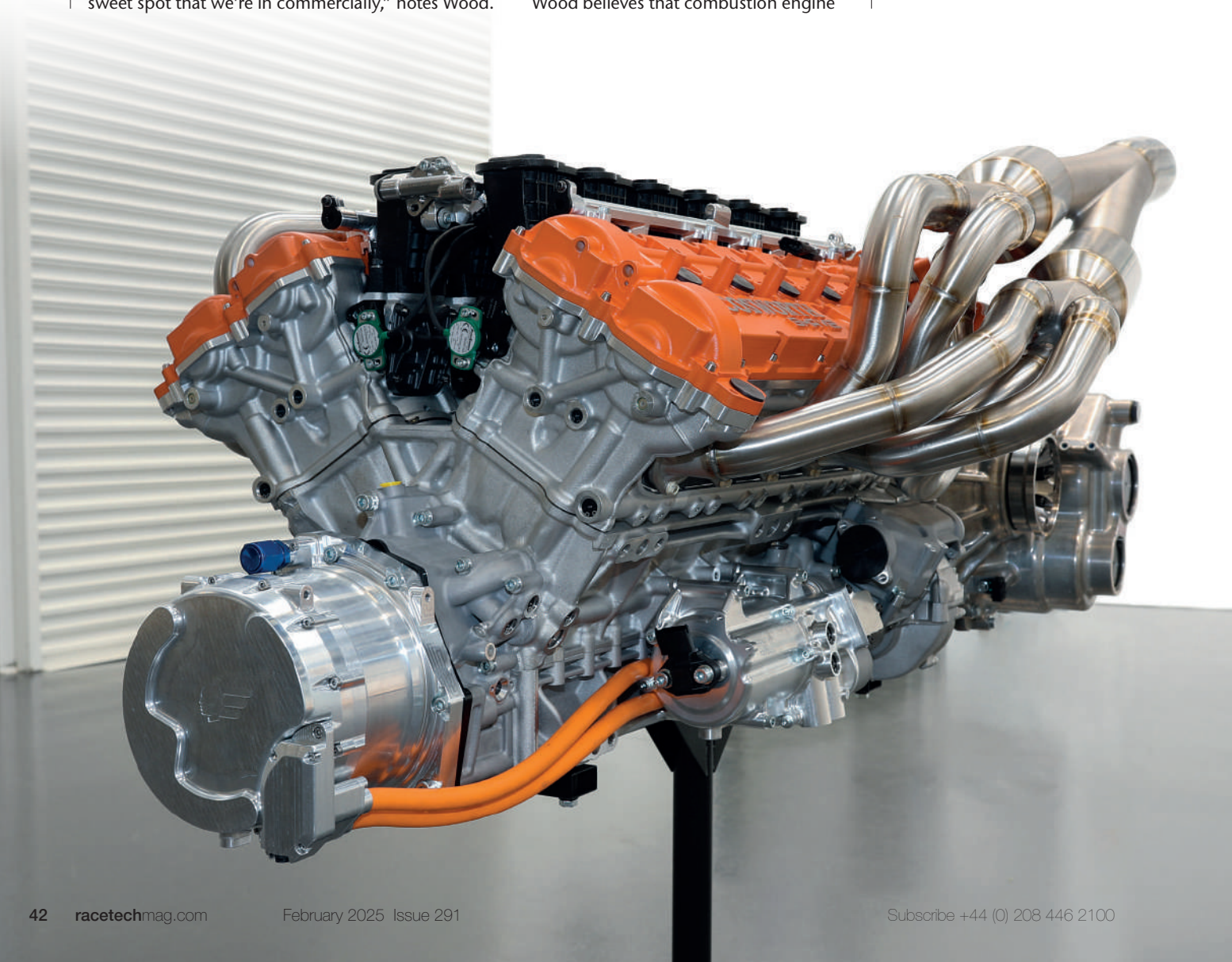
Photos: Newspress

Evolution

Before the focus shifted to electrification there were some novel concepts being promoted in the combustion engine world, such as camless valvetrains, free piston engines and partially premixed combustion. With some manufacturers starting to backtrack on electrification, could we see renewed interest in these alternative concepts?

Wood believes that combustion engine

ABOVE & BELOW The successful development of the 3.9-litre V12 for Gordon Murray Automotive's T.50 (seen above), T.33 and T.33 Spider engine confirmed Cosworth's trajectory as the go-to supplier for hypercar powertrains



development will continue along much the same trajectory as it has done recently, but he's sceptical about the chances of any fundamental shifts in technology: "Even going back a century, there aren't many points where there's been a significant change in direction. It's much more about finessing existing concepts.

"Periodically over the years, we'll have people come approach us with designs for a rotary valve, rather than a spring-operated poppet. That's quite a popular one, and it does have a lot going for it conceptually. I think Ilmor developed a rotary valve F1 engine, which used conical rotary valves."

Stories from the time suggest that the Ilmor engine offered reduced weight, a lower centre of gravity height and a rumoured 10 per cent power increase. In the end, the technology was banned in F1 before it ever had a chance to race, but Wood highlights another issue with exotic concepts.

"I suspect there's a very good chance that that is how all engines would be today if that was what Karl Benz had put in his first car in 1885 [which used a pushrod-operated poppet valve for the exhaust, alongside a sleeve valve intake]. Switching to an alternative concept like a rotary valve might offer incremental gains, but there's not 140 years of development time available [to bring it up to the same level of maturity]," he points out.

"There is definitely still some development potential out there – perhaps with things like variable compression ratios and the Miller Cycle. We've reached the stage where a turbocharged road car is up to 38 or 39 per cent thermal efficiency, which would have been unimaginable only 20 years ago. But that's been a process of iterative improvement. I don't think we'll see anything where we gain another two per cent thermal efficiency overnight."

> *"When F1 introduced mandatory bore sizes and minimum weight limits for engines it seemed like an outrage to the engine builders"*

Getty Images/Red Bull Content Pool

ABOVE & BELOW The RB17 Hypercar's V10 engine will feature Air Valve Spring (AVS) technology as the valve return actuation method. This is an innovation taken directly from F1, which enabled V10s of the noughties – such as the Cosworth TJ2005 that powered Red Bull's debut RB1 (below) – to rev beyond 19,000 rpm

Getty Images/Red Bull Content Pool

It's now approaching a decade since rumours of the internal combustion engine's imminent demise began to swirl. While there may not be a silver bullet to address all of the environmental challenges in one go, Wood believes there's still plenty of life in the technology.

"In our view, the internal combustion engine still has a place in in mainstream transport, without a shadow of a doubt," he concludes. "Electrification has never been the one-size-fits-all solution that some people were promoting seven or eight years ago. Undoubtedly, battery electric vehicles have a place in our cities because they're cleaner at the point of use, but they have their own challenges when you look at their complete lifecycle impact. We do see parts of the solution being battery electric and large parts being hybrid, but we think large parts will remain internal combustion, particularly with the interest around synthetic fuels and hydrogen."

If the internal combustion engine is indeed granted a reprieve on the road, Cosworth and its hypercar customers will be there to make the most of it. And with performance balancing across different chassis and engine configurations now a finely honed art, perhaps we will see more of these exquisite creations taking to the track. RT

THE LUXURY CAR BRAND WITHOUT THE LUXURY OF TIME!

Gary Watkins reports from a glitzy launch in Dubai where Hyundai revealed how its Genesis brand will cope with a daunting timeline to enter the World Endurance Championship in 2026

A **MANUFACTURER** new to sportscar racing will enter the rarefied atmosphere of top-flight endurance in 2026. In fact, it is entering motorsport for the first time.

There's a reason why Genesis, the premium brand of the South Korean Hyundai Motor Group that also includes Kia, has never competed on the racetrack or the rally stage before: it has only been in the marketplace for eight years. But the time was right to correct that.

Genesis announced its plans to develop an LMDh prototype under the umbrella of the Frankfurt-based Hyundai Motorsport GmbH (HMG) organisation, which has masterminded its World Rally Championship campaigns of the past 11 years, back in September in a short and sweet statement stretching to barely 50 words. In the run up to Christmas it took the wraps off its programme: essentially it told us when and how it is going to do it, gave us the name of the team and car, and even revealed the first two drivers who will lead development of the car and then segue into race seats.

When, what and where

It wasn't a surprise when Genesis revealed at a glitzy launch in the shadow of the world's tallest building, the Burj Khalifa in Dubai, that it will be entering the World Endurance Championship in 2026. That was the informed speculation prompted by the initial LMDh announcement. It will, as expected, be followed by an expansion into the IMSA SportsCar Championship in North America, one of the brand's key markets, the year after.

The WEC programme will be masterminded by an in-house squad established by HMG to be known as Genesis Magma Racing, which gives a nod to a forthcoming range of high-performance Magma models so far unveiled in concept form. The IMSA entry, meanwhile, will be made in conjunction with a partner team that has yet to be selected.

The chassis is being developed in conjunction with French constructor ORECA. It will be known as the Genesis GMR-001 Hypercar and the ICE ▶

ABOVE The endurance programme was launched against the backdrop of the world's tallest building, the Burj Khalifa, in Dubai

Photos: Hyundai

"We didn't even own a single screwdriver!"

Gary Watkins charts the rise – and swift demise – of the last Korean bid for Le Mans glory

IF YOU think that Genesis's 2026 assault on the Le Mans 24 Hours will represent a first for a South Korean manufacturer, you'd be wrong. It will come nearly 30 years after a little-remembered campaign from another marque from the Asian country – and put together by an ex-Formula 1 driver with a victory at the French endurance classic on his CV.

Bertrand Gachot, part of Mazda's Le Mans-winning line-up with the 787B Group C car in 1991 and a veteran of 47 grands prix, was in Korea seeking new business opportunities when he was asked by fledgling car maker SsangYong if he could put together a programme for Le Mans in 1996.

"I wanted to get out of driving and go into business, so I was in Korea with a business partner from Pacific," he recalls. "SsangYong wanted to change their image by going racing. They said, 'Okay, here's a budget for Le Mans, the only stipulation is that you have to use one of our engines.'"

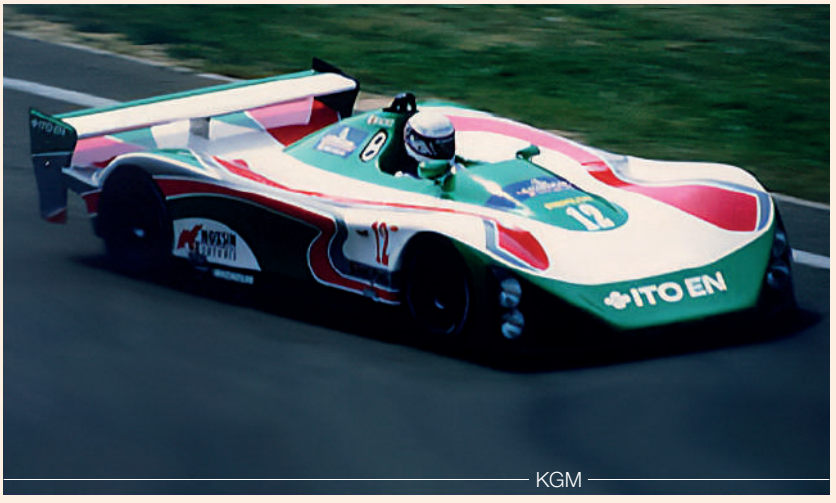
SsangYong had a technology tie-up with Mercedes at the time, so Gachot had the idea of putting one of its in-line fours in turbocharged form into a Welter Racing central-seat LMP2 in place of the team's regular Peugeot units.

"I went to Nicholson-McLaren Engines and said to them, 'what do you need?'. They said we needed five blocks, but we'd have to get them from a scrapyard because they would have gone through heat cycles to make them stronger."

Gachot put together what he calls "a virtual team". He explains that "everything was rented, we didn't own a single screwdriver". But he insists the WR-SsangYong LM94 was "a really fast car".

That wasn't evident at the Le Mans pre-qualifying day as Gachot failed to make the cut, but back at Le Mans on the short Bugatti circuit in September for the Autumn Cup the car shared with Emmanuel Clerico proved something with third on the grid. Gachot remembers leading one of the pair of two-hour races until a throttle spring issue, though he admits that his memory is a bit sketchy. Contemporary reports don't corroborate his memories.

And that was that for SsangYong and Le Mans. The project wasn't renewed. Gachot, meanwhile, turned his attention to importing the Hype energy drink into France and ended up owning the company.



KGM

ABOVE Former F1 driver Bertrand Gachot drove the SsangYong-backed WR

component of the hybrid powertrain will be a 3.2-litre twin-turbo V8 produced in-house at HMG using existing technology from the Hyundai i20 N Rally1 direct-injection in-line four. The drivers announced so far are three-time Le Mans 24 Hours winner and reigning Hypercar WEC champion Andre Lotterer and Pipo Derani, twice an IMSA champion in the top class and four times a victor at the Sebring 12 Hours.

Why now?

Genesis's move into the performance sector for the first time explains the timing of its first motorsporting adventure. There was no point in going racing before there was something to promote, points out Luc Donckerwolke, chief creative officer of Genesis Motors since the foundation of the brand. He describes its motorsport entry in the top echelons of sportscar racing as "a natural evolution" for a marque launched in 2015 and that went to market with its first vehicles in 2017.

"Racing and not having products that are close to what you race, there is a disconnect, a lack of believability or credibility," he says. That is changing with a new line of Magma models. "It is very important for us to race and get a return on investment," Donckerwolke continues. "I don't just mean in terms of marketing, but also in terms of technology and know-how, as well as inspiration for the designs."

That is why the respective Hypercar and GTP classes of WEC and IMSA are a natural fit for Genesis, according to Donckerwolke, who concedes that other categories, Formula 1 and Formula E included, were discussed. Genesis is a style-led car maker and its CCO has a catchphrase that goes "brand is design, design is brand". Donckerwolke points out that the organisers in WEC and IMSA "don't want all the cars looking the same, are really strong on having different designs" and that is something Genesis "really welcomes". The LMDh rules allow it to impart its DNA on its forthcoming racer, shown as a half-scale styling model at the launch.

Genesis and HMG started talking about the WEC and IMSA only 18 months ago, reveals Donckerwolke. He invited Cyril Abiteboul, president of HMG, to one of his studios and outlined his vision of a

> *"It was the longest weekend of my life, waiting for a 'are you out of your mind?' or a 'yes' response to my email"*

Genesis racing at Le Mans.

Yet Hyundai's interest in top-flight sportscar racing is known to date back beyond that meeting between Donckerwolke and Abiteboul – and it predates the recruitment by HMG of the former Caterham and Alpine F1 team boss in January 2023. It appears that its real interest was in hydrogen and Le Mans organiser the Automobile Club de l'Ouest's plan to introduce the alternative fuel, a move now set ▶

BELOW The half-scale model of the Genesis GMR-001 Hypercar

BELOW The ability to add its own styling cues to the ORECA spine was a lure for an image-conscious brand

LEFT The expertise of Hyundai's engine division in Germany will be put at the disposal of the WEC project

for 2028. Hyundai is one of the few manufacturers to sell a fuel-cell car, the Nexo SUV, and is known to have sat on the relevant FIA/ACO working group.

What isn't clear in the narrative of the Genesis LMDh programme is the part played by two key regulatory decisions. The first was the decision to allow combustion-engined hydrogen prototypes alongside fuel cell cars, announced in 2023, and the second was the FIA's diktat early in '24 that hydrogen vehicles competing in international motorsport will have to store the fuel in liquid form. The fuel-cell Nexo uses gaseous hydrogen.

HMG technical director Francois-Xavier Demaison, who joined HMG in June '23 from the Williams Formula 1 team, explains that these shifts made a hydrogen programme a non-starter for Hyundai. He believes the ability of a fuel cell to match the performance of a combustion car is "many years away".

Why an LMDh?

There wasn't a choice, insists Abiteboul. The timeframe of the project that wasn't signed off until the start of September simply wouldn't have allowed Genesis to start with a clean sheet of paper, even if there was interest in the route into the Hypercar division taken by Toyota, Ferrari and Peugeot.

"The initial expression of interest from corporate headquarters was to have a bit more freedom and authority on the design," explains Abiteboul. "But I said it depends on what kind of timing we are talking about. If you give us three years, yes, if you give us one year, it's a no-go." He describes LMDh as the "most accessible" approach.

There was a second consideration. No LMH has so far raced in IMSA and will not until round two of this year's series when Aston Martin joins with its Valkyrie AMR-LMH. There was a view that Genesis needed to "play it safe", admits Demaison, though he concurs with Abiteboul that "the big reason we went for this option was the timeline".

> *"It is very important for us to get a return on investment. I don't just mean in terms of marketing, but technology, know-how and inspiration"*

He concedes that HMG, as an operation focused on rallying and touring cars with its line of TCR machinery, didn't have the required level of expertise. To do an LMH, he says, "you would need a mini-F1 team". Producing an LMDh provides an obvious short cut: the GMR-001 will be built around ORECA's chassis spine like the Acura ARX-06 that came on stream in IMSA in 2023 and the Alpine A424 that arrived in the WEC in 2024.

The partnership with ORECA

Abiteboul reveals that HMG "conducted a thorough assessment" of the four constructors licensed to work with a manufacturer on an LMDh project. The choice was narrowed down to Groupe ORECA and Dallara Automobili, with the former getting the nod. ▶

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"It wouldn't be fair to go into the detail and you can imagine that there were suppliers not available for this project," says Abiteboul, in a nod to Multimatic Motorsports's close ties with Porsche. "Motorsport, at the end of the day, is about people and passion. We are confident of our choice to go with Hugues [de Chaunac, ORECA's founder and boss]."

The motorsport entry of Genesis wasn't signed right at the start of September. Donckerwolke reveals that a scheduled presentation on the last Friday of August was cancelled as a result of conflicting agendas and that he was forced to send an email to the company leadership.

"Basically my email was, it is now that we have a slot to enter endurance, we will be racing to this calendar and this is the level of investment," he explains. "It was the longest weekend of my life, waiting for a 'are you out of your mind?' or a 'yes'. On the Tuesday it was a 'yes'." A quick decision was important: "Either we decided yes or we made an already very tight timeline impossible."

> *"Motorsport, at the end of the day, is about people and passion"*

Work had, however, already started on the project. It got underway in the summer because there wasn't time to lose if Genesis was to be ready for a 2026 WEC entry. Stylists had already been sent to ORECA to start working on the aero, while at HMG the engine was being schemed.

"To be very honest I had sent my team of designers to Hugues before I had the decision," reveals Donckerwolke. "I had to do it to meet the deadline, with the risk that I would have to call them back. But I was able to tell them to go flat-out and carry on."

The choice of engine format was driven by the tight timeframe for development of the GMR-001, which will be just 16 months from sign-off to homologation at the end of next year.

"If you look at where our competitors were when they started their programmes, they already had an engine up and running," he says in reference to the likes of Porsche and BMW using variants of engines already used respectively in LMP2 and the DTM. "So that is why we decided to go for the short cut of using the WRC engine as the base. It may sound a bit strange, but it is a good short cut."

Designing an engine from scratch, says Demaison,

RIGHT All smiles but the 16-month timeline from sign-off to homologation is a tight one that has called for a number of short cuts

BELOW RIGHT Since its inception in 2012, Hyundai Motorsport, under its N brand, has carved its reputation on the world rally stages but also on the racetrack with its TCR-spec touring cars

BELOW The 1.6-litre, four-cylinder, turbocharged engine that propelled Thierry Neuville to the 2024 WRC crown will form the base of the V8 developed for endurance racing

"would have been too risky, so we very quickly decided to play it safe". There isn't time for a false turn, he points out.

Abiteboul points out that the approach Genesis is taking isn't new. Glickenhaus opted for a similar route when it commissioned Pipo Moteurs in France to develop a V8 for its 007 LMH: the French engine specialist has worked with a number of manufacturers on four-cylinder turbos, Hyundai included. It developed its Rally1 engine when the Korean manufacturer returned to the WRC in 2014 and still produces the powerplants for its Rally2 customer car.

The plan is that the engine will run on the dyno in February with a first roll-out of the car scheduled for the summer – Genesis isn't being more specific than that.

Running a programme in one of the two arenas for which it is eligible makes sense given how tight the programme is: it is a "staged approach", says Abiteboul. The decision to choose WEC over IMSA – in a reverse of the order in which BMW did things with its M Hybrid V8 – was important, he continues, because Genesis will be running the car itself in the world championship.

"I don't want to have any filter or firewall between us and the car," he says. "That is behind the decision to do WEC [first]; we know that in IMSA we will never be able to do it in such a way."

Building a team

Genesis has to create a team for its entry into the WEC. Or rather mould a team that up until now has only operated on the rally stages. That explains a link-up with the French IDEC Sport squad, which finished third in LMP2 at Le Mans in 2024, in what it is calling its trajectory programme. Existing staff from HMG as well as new recruits will be embedded in the crew that will run IDEC's second ORECA-Gibson 07 in the six-round European Le Mans Series in 2025.

"We are going to work with people to make us self-sufficient in the future: the end game is to have autonomy," explains Abiteboul. "We had the opportunity to build a partnership with IDEC to do a number of things, like ramping up our people, our understanding, our infrastructure, our facilities. And once you do that you have to ask yourself, okay, how about the drivers?"

Genesis has already announced that its P2 entry with IDEC will be driven by F1 refugee Logan Sargeant, who lost his Williams drive after the Dutch Grand Prix, Indy NXT race winner and three-time W Series champion Jamie Chadwick and Porsche Supercup racer Mathys Jaubert. They are being given a platform to prove that they deserve a Hypercar seat in 2026.

What happens to the trajectory programme beyond 2025 isn't entirely clear. But the Genesis WEC team will stay close to IDEC, at least in physical proximity. HMG is moving to new premises in the Frankfurt area that are most suitable for the LMDh programme, but GMR will have a base on a new technology park at Paul Ricard, adjacent and with access to the Mistral Straight. It was built by Groupe IDEC International, the race team's parent company.

Long-term vision

Genesis is in sportscar racing for the long haul. It has made a firm commitment to the end of the current rules cycle, which was extended by two seasons to the end of 2029 last summer, and is already looking beyond that and the new rule set due for introduction in 2030.

"The trade-off with this programme is what we are having to do in order to be ready quickly, but we also know the sort of technology we want to bring mid to long-term," says Abiteboul. "I don't want to be more specific than that, but we have plans. It is almost like we are running two programmes in parallel."

Genesis is taking its first steps in endurance racing, but it is, says Abiteboul, very much "here to stay". RT

FIA

THE RACE F1 CANNOT AFFORD TO LOSE

ABOVE For 2026, the FIA has mandated the use of 100% sustainable fuel derived from 'Advanced Sustainable Components' (ASCs), ensuring they are sourced from non-food biomass, renewable feedstock of non-biological origin or municipal waste, and meet stringent greenhouse gas emissions thresholds

A cumulative TV audience of more than 1.5 billion people can be a double-edged sword when you've committed to achieving a net zero carbon footprint by 2030. **Olivia Hicks** quizzes the woman who shapes Formula 1's sustainability strategy

ON PAPER, Formula 1 looks like the least likely leader for a carbon-free future: efficiency might well drive every move the engineers make but, to the outside world, the sport is synonymous with petrol fumes and loud noise — albeit being quieter than in previous decades. And that's just on track. F1's 10-month world tour to 21 countries in 2024 didn't inspire an image of smog-free blue skies.

But Formula 1, an ever-evolving engineering competition laced with high-stakes contact sport, is in a prime position to take the reins, says Ellen Jones, Formula 1's Head of Environment, Social, and Governance (ESG).

"It's already in the culture to constantly be changing," Jones insists. The sport diverges from its peers on the pitch or court by routinely rewriting its rulebook every few years. For 1982, new regulations altered the look of the cars by banning ground-effect models with low-hanging side skirts. For 1998, the single-seaters took a revised shape yet again – narrower and sporting grooved tyres.

> *"The reductions with Sustainable Aviation Fuel are big numbers, but we still have to do all the one per cent projects that add up to change"*

The turn of the century brought two decades' worth of rule amendments: from the advent, via a back door, of double diffusers, through KERS (Kinetic Energy Recovery Systems), to the Drag Reduction System, V6 turbo hybrid power units and the partial return of ground-effect.

In 2026, a new series of regulations will go into effect, introducing lighter cars fuelled by 100 per cent sustainable fuels and increased hybrid power. Off track, Formula 1 will continue to carve away at its carbon emissions, a 2030 net zero deadline looming ahead.

"When you talk about sustainability – the change curve – people are like 'Oh, do I want to change?' ▶

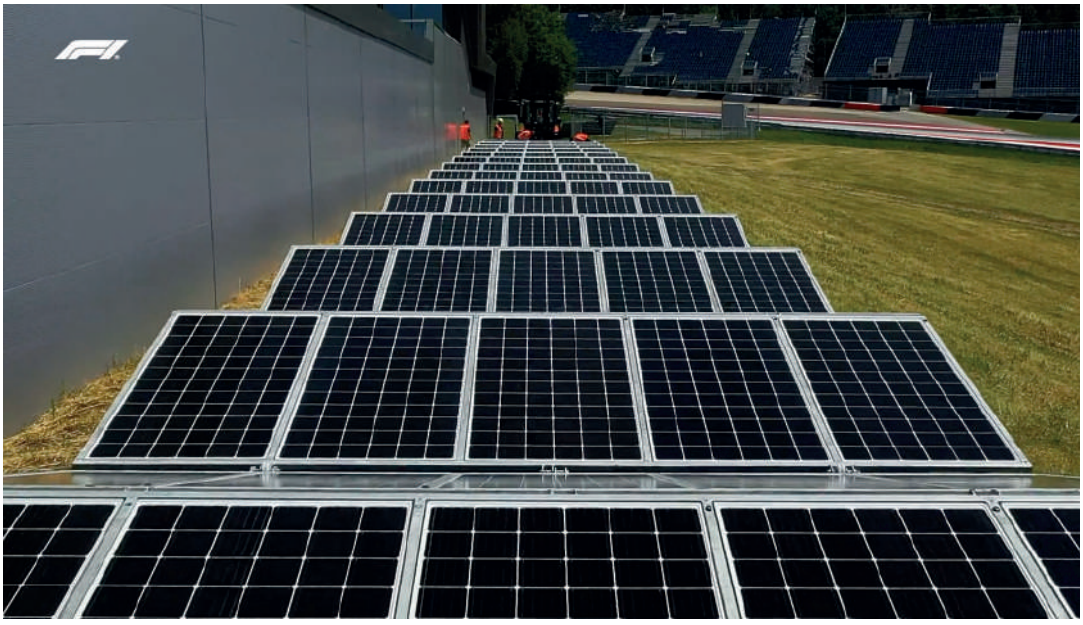
but it's expected here at Formula 1," Jones says. "Whether it's the cars on track getting just that much faster or the broadcast or just us getting from race one to race two, people know that we're constantly trying to raise the bar on what a great event looks like, and therefore [we're] very resilient to change."

Jones is part of that "we". Before she joined Formula 1, Jones headed sustainability at Pret a Manger. Despite jumping from packaged sandwiches to 14,000-part racecars, she insists the two spheres aren't too different.

"The fundamentals of sustainability are always the same: How do we look at our impact in terms of the environment and the communities around us?" Jones says. "It's about global supply chains. So how do you look at change in different markets with different infrastructure? How do you move it from point A to point B, whether it's a car or a sandwich ingredient? All of that is actually using the same infrastructure and system that we have in place in the world around us."

A big part of sustainability, Jones insists, is determining how to change an organization or business model and what data to look at to ensure goals are "on track". For Formula 1, environmental regulations have been swift considering the sport's first Impact Report only came out in 2024, and Jones, joining in 2022, was Formula 1's first head of sustainability.

In April, the series announced it had cut



ABOVE & RIGHT To an extent, F1 relies on the commitment of its stakeholders to pursue their own sustainable journey. The Mercedes-AMG Petronas F1 Team is set to quadruple aviation emissions reduction by the end of 2025, following investment in SAF certificates. It has also achieved 98% biofuel coverage in its race and marketing trucks and generators

LEFT Aggreko and Formula 1 piloted a centralized power generation compound at the Austrian Grand Prix, which will be rolled out to all European races this season. Monitored by real-time telemetry, the compound uses renewable sources like solar panels, biofuel, and hydrotreated vegetable oil (HVO) to reduce carbon emissions by more than 90%

emissions by 13 per cent from 2018 and it did so in a handful of ways, including trialling feeder series cars with 55 per cent sustainable fuel, powering 75 per cent of grands prix through renewable energy, and reducing logistics-related emissions by 83 per cent across the European season by using DHL biofuel trucks. Formula 1 has continued to receive the FIA's Three-Star Environmental Accreditation each year and, in 2023, it became the first series with all teams reaching the same environmental benchmarks.

In November, Formula 1 shook hands with Qatar Airways to develop Sustainable Aviation Fuel (SAF). Logistics and business travel remain the largest carbon emitter in Formula 1, with shuttling parts, tyres, and people across the globe making up nearly 80 per cent of Formula 1's total emissions. In all, the sport emitted 223,031 tonnes of carbon in 2023. The SAF program, along with Formula 1's current DHL partnership, is anticipated to reduce logistics emissions by 19 per cent.

> *"In a lower risk environment, you'd be like, 'Oh it doesn't work, no problem.' That's not an option here"*

"Now looking at Sustainable Aviation Fuel, a minimum 80 per cent reduction when it's used in the context of those flights, those are big numbers," Jones says. "They're not the only numbers: We still ▶

have to do all the one per cent projects that add up to change. But, it's very good when you have these types of technical leaps like alternative fuels, and you can prove that they work and how they can scale."

Despite Formula 1 being blessed with near-constant technological evolution, the series faces other glaring challenges – many of them double-edged swords. While Formula 1 has a global stage to inspire the next generation of road vehicles, it also comes with the scrutiny of 750 million eyes and no second chances.

"Any change that we do put into place, it can't fail," Jones explains. "If you're working in a lower risk environment, you'd be like, 'Oh it doesn't work, no problem.' That's not an option here. So we have to really test and learn and do that all off track before we bring a solution to an event, to our operations and building in that timeframe."

Formula 1's investment in sustainable fuels, whether on the road or in the sky, should be a comfort for

Red Bull Content Pool

environmentalists: the series will ensure those high-profile gambles succeed. While the series also benefits from a non-spec format that pushes the boundaries of engineering, Formula 1 has less control when all the moving parts, contractual agreements, and modern constraints of technology are considered. It must trust promoters, teams, and manufacturers to follow the same carbon-reducing structures.

"We want our cars to not only run faster, but we want our cars to have a lower carbon footprint. You have the research and development of the teams who can make that happen and develop what those new technologies could be," Jones says. "That's exactly the approach we use with our race promoters. We don't tell them how to power their event. We tell them we want it powered by renewable energy, and then they build different solutions based on their infrastructure."

Courtesy of F1

ABOVE RIGHT Sustainability and F1 might be a hard sell to the outside world, but Ellen Jones has embraced the challenge

> *"Sustainability needs people to care about it, and sport has that ability to bring people in and get them to care"*

ABOVE LEFT The investment in Qatar Airways' project to develop Sustainable Aviation Fuel (SAF) underlined F1's ongoing shift towards alternative fuels across all aspects of the sport

LEFT The racing cars themselves account for just 0.7 per cent of F1's carbon footprint

Spectators remain sceptical. Fans on social media call out Formula 1 for pushing on-track emissions cuts, like sustainable fuels, when the cars make up less than one per cent of total emissions. Others raise eyebrows at the motorsport series' reliance on carbon offsets. And while Formula 1 insists it remains on course to reach its 2030 deadline, other companies claim the same even when experts say most corporations won't meet their net-zero deadlines in time. Cynicism and criticism are understandable: across the globe, technological innovation has largely increased resource and energy consumption even as new alternative energy solutions pop up. In other words, solar panels aren't putting coal plants out of business.

So, what makes Formula 1 certain it can effectively create a lasting, and on-time, fix? Speed, the love of sport, and recognizing one size doesn't fit all.

The sport doesn't just breed efficiency within tight margins, but "sustainability needs people to care about it, and sport has that ability to bring people in and get them to care," Jones says. She is aware that all the possible solutions, from SAF to reusable paddock club materials, are part of a larger picture. "There's never, sadly, a one-size-fits-all approach and that silver bullet. But I think what's really important is having technologies that work in the infrastructure that we have today so that we can keep innovating because we need to make those carbon reductions now."

In 2025, Formula 1 will continue to expand the picture by introducing new ways to decrease emissions, like regionalizing the race calendar and partnering with Aggreko, an energy provider, to reduce carbon-intensive power use during the European race calendar. The Austrian Grand Prix acted as a guinea pig the past two years and, in partnership with Aggreko, tested a centralized power generation compound that reduced paddock, pit lane, and broadcast emissions by 90 per cent through a combination of solar power, biofuels, battery storage, and hydrotreated vegetable oil (HVO).

The series has just five years to shrink carbon emissions by 50 per cent and reach carbon neutrality by offsetting the rest. Just as Formula 1 does every few years when a group of FIA members gather to rewrite the rulebook, the series will continue to stretch the boundaries of technology innovation, insists Jones.

"It's such a Formula 1 thing to say: 'How do we do this even better?'" RT

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SUSTAINABILITY – *WITHOUT* COMPROMISING PERFORMANCE

Once a source of great pride, motorsport's expertise with composite materials is hard to reconcile with the drive for sustainability. Or is it? **Chris Pickering** talks to the pioneers of vegetable-based chemistry in composite tooling

INNOVATION often comes from the ideas that others have overlooked – or sometimes dismissed completely. The story behind the revolutionary Ru-bix Halo-S tooling board, which won the William Kimberley Green Tech Award at the recent World Motorsport Symposium, involves both.

Tooling boards are the first part of the composite manufacturing process. They're blocks of material that are shaped to create the tooling used for laying up carbon fibre. In some cases, they're used as a direct tool for manufacturing. In others, they're used to produce a carbon fibre tool, which is then employed in production of subsequent parts. In either case, they are typically made with epoxy resins.

Most epoxy resins are formed by reacting epichlorohydrin with bisphenol A. Both compounds are known to cause significant health issues, and both are traditionally derived from fossil fuels. The curing of epoxy is also very energy intensive, with parts kept in an industrial oven for up to seven days while they solidify.

The Halo material is said to address all three problems, starting with bio-derived ingredients that are non-harmful, using far less energy to process them, and ultimately delivering significant cost savings too. Most importantly, it does so with a material that behaves in exactly the same way as traditional epoxy as far as composites production is concerned.

"It's always going to be difficult to get a truly sustainable epoxy, given the fundamental chemistry behind it. There are things you can do to make epoxies less impactful, like using biopolymers as hardeners, but there's a limit to how much you actually gain," comments Ru-bix chairman Dr Barrie Colvin. "We set out to mimic the thermal behaviour of those materials with a sustainable alternative that can be used without any changes to the manufacturing process."

> *"Epoxy is around 7 to 8 kg of CO_2 emitted for every kilo of finished product; with the Halo board that number is between 1 and 2 kg"*

Among the properties that make epoxy resins suitable for composite tooling are a low coefficient of thermal expansion (CTE) and a high glass transition temperature (T_g). In a nutshell, this limits the expansion that composite engineers have to allow for while the tool is placed in the autoclave and ensures that it provides sufficient rigidity at elevated temperatures. Although the degree of thermal expansion is relatively small on a typical motorsport part, it can run to multiple centimetres on a large component like a wind turbine blade.

"Aside from the cost and the environmental aspect, there can be other downsides to using epoxy," points out Ash Colvin, managing director of the family-run firm. "A lot of epoxy materials can produce significant ▶

LEFT Formula 1 teams are hot on secrecy, but at least four on the current grid use the sustainable tooling boards

amounts of dust, they can give off a strong odour when they're machined, and they tend to be very brittle. One of the advantages of Halo is that it's less brittle and therefore more practical to use as a direct tool, so you're also reducing the need for additional composite tooling."

Inspiration

Halo is a recent creation, but it draws inspiration from a career stretching back more than half a century.

Barrie began as research scientist at Shell in the 1970s, where he led a team tasked with developing a new range of products. Rather than stick with the company's core range of petrochemicals, they took a deliberate decision to explore what could be done with plant-based polyols – something that nobody else was doing at the time.

"We were given free rein to experiment, so it really was just a matter of curiosity to see whether or not we could use other oils for the same purpose as the fossil-derived components," he recalls. "We knew that there were similarities in terms of molecular structure, so we reasoned that this should give them somewhat similar physical properties."

This hunch proved to be correct. Barrie's team developed a range of vegetable-derived polyurethanes that offered exceptionally good thermal stability.

He left Shell in 1978 and went to work for a company that used similar technology to develop foam insulation for pipelines, refrigeration and cold storage.

One of the first projects that used this technology was an above-ground ammonia pipeline installed in India in 1980. It ran for 11 km from a factory to the neighbouring port, carrying liquid ammonia that needed to be kept at very low temperatures, despite the warm ambient conditions. Barrie and his team developed a polyurethane foam based on locally sourced sunflower oil, but it lacked the high temperature performance required for applications such as composites manufacture.

In 1982, he set up his own company, IFS, which later set another sustainability landmark by pioneering the use of non-CFC blowing agents in polyurethane foams. Major manufacturers like Portakabin started switching to IFS from much larger chemical suppliers, and the company (sold in 2017) remains active today.

Under Barrie's leadership, IFS continued to expand its portfolio of high-performance thermoset materials, but the interest in the use of sustainable, non-fossil derived products wasn't always there at the time.

> *"Finding the resins and processes that will deliver a significant CO_2 saving rather than just ticking a box"*

"I remember giving a talk at the UTECH conference in Singapore in 1994 about some of the things that we could make with natural oils," he recalls. "It was relevant to an awful lot of applications from building panels to the insulation in refrigerators, so I set 10 minutes aside for questions at the end. Instead, there was just silence. When I spoke to people later on, they said 'the petrochemical stuff we've been using works perfectly well, so why would we want to change it?'"

The prevailing attitude was much the same when Ru-bix Advanced Materials was formed in 2015 and ▶

LEFT Ru-bix Advanced Materials Chairman Dr Barrie Colvin receives the William Kimberley Green Tech Award from Race Tech Publishing Director Soheila Kimberley

BELOW The company's grounding in fundamental polymer science enables it to turn innovative chemistry into leading-edge products: the making of the sustainable tooling boards

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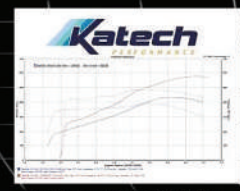

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the conversation turned to the use of vegetable-based chemistry in composite tooling.

"Someone came up to us at the Advanced Engineering Show and said, 'it's been tried before and it doesn't work'," Barrie recalls. "They even said they'd refuse any samples as they just didn't believe it was possible."

This outright denial only served to strengthen Barrie's resolve. Decades of experience with vegetable-derived thermosets suggested that they could be developed to offer a viable tooling board material that was not only more sustainable, but also cheaper and more pleasant to work with.

The end result is a hybrid polymer. Instead of a single material, it uses a combination of ingredients, including bio-carbon and recycled plastic, polymerised together to combine the desired range of physical properties. With a T_g of 140 deg C, the sustainable board is said to exhibit very similar behaviour to a fossil-derived epoxy board of the same density.

"When you first talk to people about a sustainable product, they almost always expect it to be more expensive and less effective than the existing solutions," comments Ash. "We wanted to make sure that Halo would meet the same performance requirements as a traditional epoxy and that it would do so at a significantly lower cost. The aim has always been to make the transition as simple as possible, with no change to the processes or the capabilities."

> *"At the end of my talk there was just silence. Later, they said, 'The petrochemical stuff we've been using works perfectly well, so why would we want to change?'"*

Halo production still starts with plant oils, but it uses different feedstocks and different chemistry to Barrie's earlier projects such as the pipeline.

"There are a lot of plant oils out there, and the chemicals within them vary tremendously," he notes. "When I first started working in this area, it was things like sunflower oil and rapeseed oil. Chemically, those are triglycerides. And there are certain things that you can do with triglycerides that allow you to produce a similar polymer, but you can't achieve the high T_g that you need for the sort of industries that we're talking about here."

Broader challenge

While the use of bio-carbon and recycled plastics is significant, they're just two elements in a much broader sustainability challenge.

"We're seeing a massive push towards sustainability in motorsport and I think something that's going to become incredibly important for all manufacturing businesses in the future is the concept of lifecycle impact," notes Ash.

"When we talk to the composites industry a lot of people are very much fixated on the use of bio-resins. Yes, those are naturally grown, but the CO_2 savings can be next to nothing in some cases. Having something that's rich in bio-carbon doesn't really help if you're expending a lot of energy to access that. It can actually generate a lot of CO_2. We're trying to find the correct resins and processes that will deliver a significant CO_2 saving rather than just ticking a box to say it's bio-derived."

Ru-bix is actively attempting to steer the conversation away from bio-carbon content and onto CO_2 savings. After liaising with early adopters of Halo, the company took the decision to state the global warming potential (GWP) of the material on its datasheets rather than a percentage of bio-carbon.

"The process of creating an epoxy board is very ▶

ABOVE The Callum Skye EV features two departures from conventional manufacturing methods: Codem Composites used a direct tooling approach by harnessing Ru-bix's Halo-750 sustainable tooling; it also replaced traditional carbon fibres with flax fibre

BELOW Ariel's electric E-Nomad used Ru-bix's Halo high-performance, sustainable tooling boards. It also features bio-composite fibre bodywork that is recyclable

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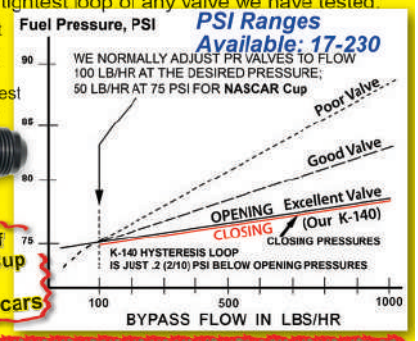

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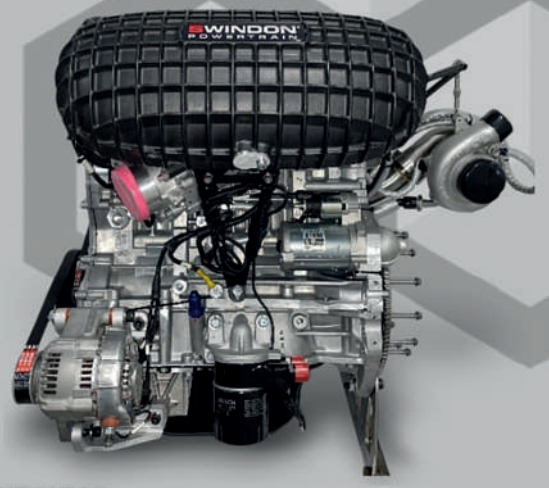

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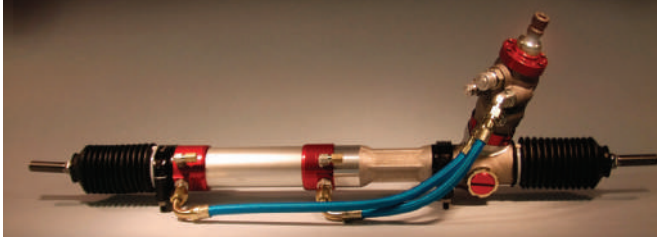

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energy-intensive," comments Barrie. "There are databases now that allow you to look up the GWP of any material. Epoxy – because it starts with fossil-based materials and then applies a lot of processing steps – is around 7 to 8 kg of CO_2 emitted for every kilo of finished product.

"With the Halo board that number is between 1 and 2 kg, so we're talking about a massive difference. That's because it starts with a plant feedstock and only requires a couple of low-energy processing steps to get to the material that we buy in and process into the board. The energy consumption of our processes is very low as well."

Traditional epoxy is poured into the mould and requires the prolonged application of heat to cure. Halo is also a thermoset material, but it begins to react at room temperature while being mixed. Ru-bix has a continuous production line with large roller tables, where the material solidifies. It's then put into an oven for post-curing, which lasts 24 hours, as opposed to the week-long curing process with epoxy.

Recycling

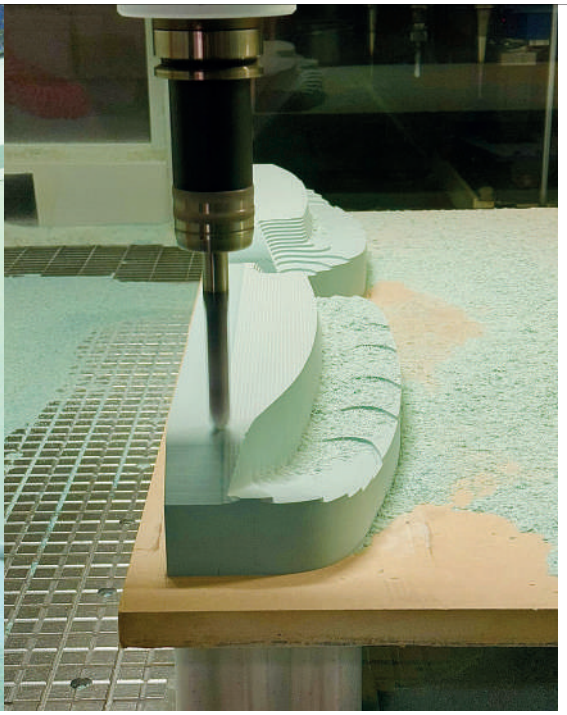
Tool production is just one step in the composite manufacturing process. However, it can be a significant contributor to the carbon footprint in specialist applications like Formula 1, where sometimes only a handful of parts are made on each tool. More to the point, there's a growing awareness that manufacturing businesses need to address each and every stage of the product's lifecycle to be truly sustainable.

As well as working on the processes and the raw materials, Ru-bix has been looking into end-of-life and recycling options. For large boards, one

RIGHT A Belotti CNC machine being used at Codem Composites for milling and trimming of the Ru-bix Halo tooling board

RIGHT The finished product: in this case, a clam shell produced for the Callum Skye

LEFT One of the key ingredients that make Halo-S boards unique is their utilisation of recycled plastics



possibility is simply to re-machine it into a tool for a different part once the original production run is finished.

"A lot more people are starting to reuse the tools," comments Ash. "You need a really big tooling board to make something like the floor for a Formula 1 car, and you need quite a lot of material below that to give it the stability. If you start off with a 500 mm board, you can skim it flat after you've used it and still have a depth of 200 mm left to reuse. We've noticed a significant shift in the mindset – people are starting to save tiny little offcuts to jigsaw together, which would previously have gone in the bin."

Ru-bix is also working with various partners on end-of-use applications. Much of the recovered material now goes to high-end furniture makers, where it's used as a core material in place of wood. The company also worked with automotive OEM Cupra to produce a series of 3D artworks for its UK dealerships.

For the next step, Ru-bix is now investigating the option of purchasing an industrial shredder. This would allow the waste material to be returned to the company and shredded into sub-millimetre particles that can then be bound with a sustainable resin to produce its own composite. As tends to be the case, the recycled material will be a slightly lower grade, but Ash anticipates it being used for less critical applications like jigs and fixtures.

Exponential growth

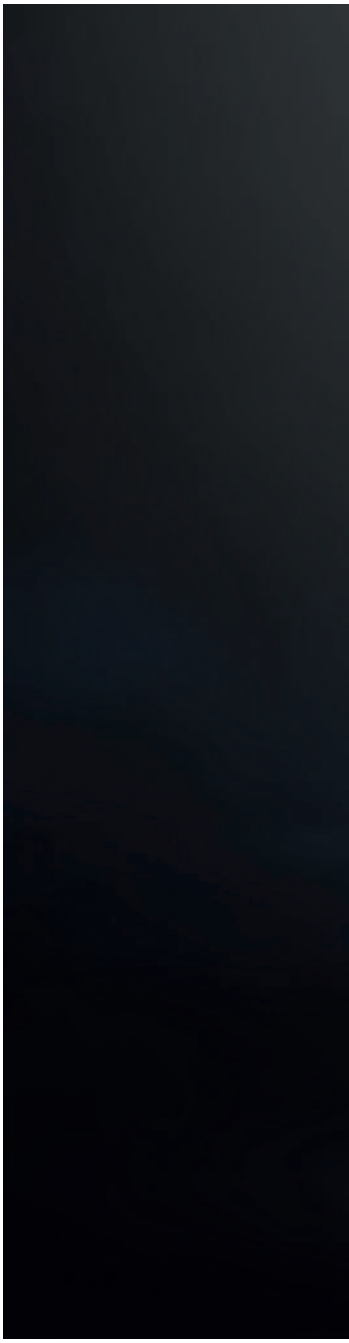
The growing emphasis on sustainability in motorsport has led to conversations with a number of Formula 1 teams looking into Halo. Ru-bix already supplies several subcontractors who produce parts for the motorsport industry. Additionally, the company has worked with specialist road car manufacturers on low-volume projects and concept cars, such as the Callum Skye and the Ariel e-Nomad.

The Halo side of the business is growing exponentially, we're told. Work has begun on training new staff and the plan is to add a late shift to increase production. There are also several new products in the pipeline.

All of this can trace its origins back to that spark of inspiration to look at vegetable-based chemistry, long before sustainability and greenhouse gas emissions were on the agenda. Proof that sometimes it does pay to do things differently. RT

WHY THE ART OF SLOWING DOWN IS EVOLVING *FAST*

AP Racing managing director David Hamblin discusses the emerging trends in the motorsport brake market. By **Chris Pickering**



IT'S an acknowledged fact that good brakes can win races. From last-minute lunges to 24 hours flat-out without a pad change, brake technology can change the shape of a race.

It's also a rapidly developing field, with all the traditional challenges of stopping power, modulation and weight reduction combined with new themes such as electrification and the use of ABS. On top of that, it's an area where motorsport technology can be applied to give very real benefits on the road.

"We do see technology migrating from race applications to the road – and sometimes in the opposite direction too," comments AP Racing managing director, David Hamblin. "We've got high-temperature seal technologies and cooling strategies from motorsport being used on road cars with ceramic discs, which run at higher temperatures than conventional cast iron. We've got anti-drag technology from NASCAR used to improve the range on electric cars. And coming the other way, we've got forging technologies taken from the road car market that are helping to make our motorsport products more affordable."

He points to the new entry-level PRO SPORT competition range as an example. This uses the same piston, seal and seal groove technology that you'd find in a professional motorsport caliper costing twice as much. But a simpler, horizontally-forged body design is used, which trades a small weight increase for significantly lower manufacturing costs.

"Around 90 per cent of our calipers are forged aluminium, from top end race applications down to road cars, but we use two different forging technologies," explains Hamblin. "The difference is whether you go from the top to the bottom of the caliper or the inside to the outside. Vertical forging – from top to bottom – allows you to get a more complicated near-net shape. The downside is that you have to hit it more times, so it's a longer and more expensive process.

"Horizontal forging requires fewer cycles, so it's cheaper. The grain structure and the strength of the material are the same, but you can't get quite such intricate details into the near-net shape forging, which means that you can't optimise the design quite so aggressively for weight. We're only talking a few hundred grams difference, though, it's not kilos."

As an aside, Hamblin notes, AP Racing has just launched what's believed to be the world's first forged steel caliper. Aimed at full-size pick-up trucks and armoured vehicles, it's a world away from motorsport, but it's rooted in the same philosophy of maximising brake performance for a given packaging volume. In this instance, forged steel allows the use of much thinner sections than either aluminium or traditional cast iron, which enables a more powerful brake to be packaged inside the 17-inch wheels commonly used in these applications.

> *"A road car might go a whole year without its ABS being activated; when you see significant ABS intervention six times every lap, the impact on things like seal wear is an order of magnitude different"*

Under pressure

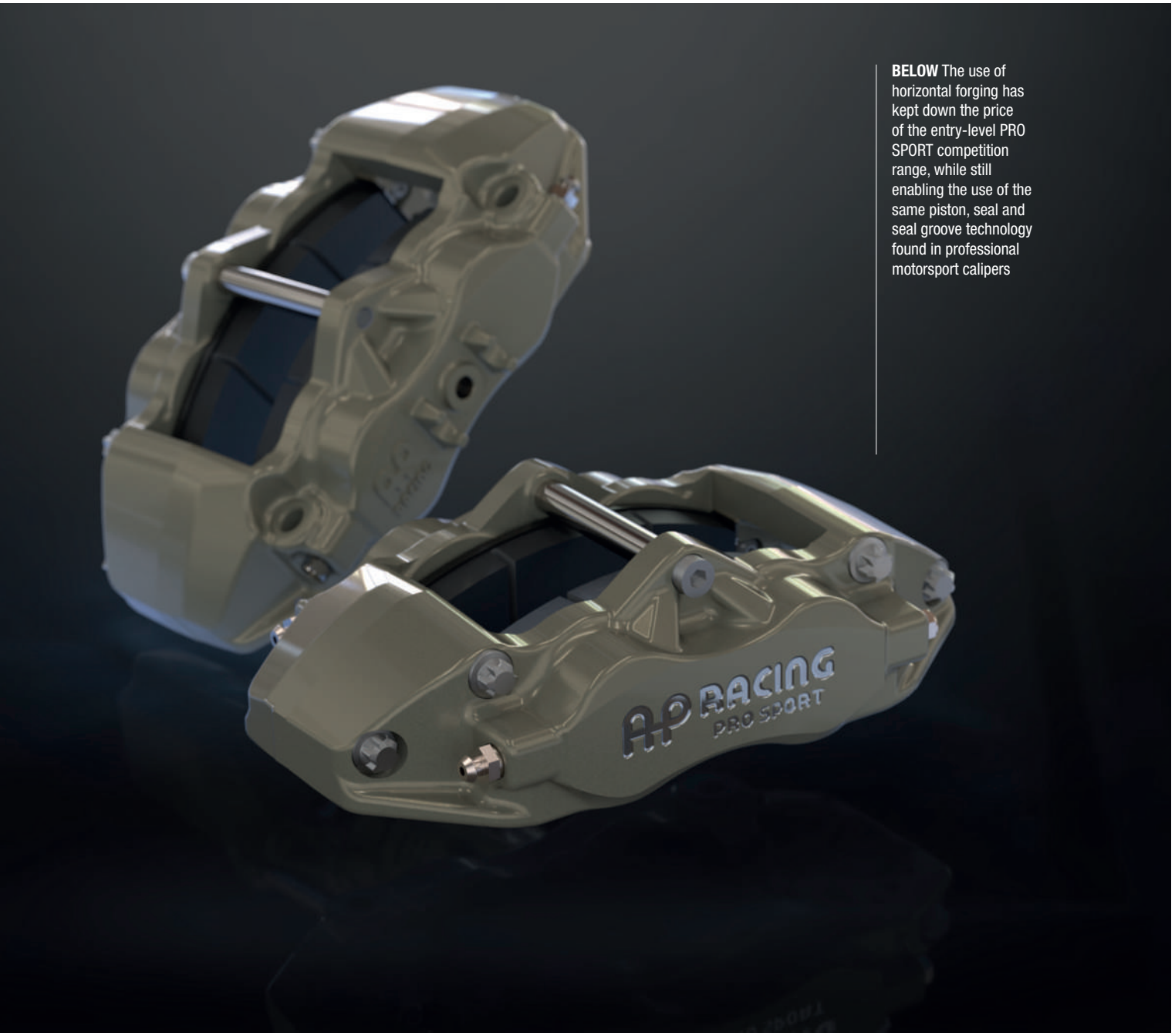
One of the most common trends that has impacted the design of race calipers is the adoption of ABS. Most GT racing categories (including those in IMSA and the WEC) now allow the system, which has caused drivers to change their braking style.

"Motorsport ABS systems are extremely effective, and drivers know that they can just smash the pedal down and brake as hard as they can without locking the wheels," notes Hamblin. "That has increased the brake pressures hugely. We're talking 70 or 80 per cent higher than a non-ABS brake system in some cases, which drives changes to the design and the sizing of the caliper."

More pressure means higher loads in the caliper. Careful design is required to maintain stiffness under these conditions, as professional drivers will be able to detect even tiny amounts of deflection in the form of increased pedal travel.

The master cylinders have changed too. Traditional cut-off ports can lead to a phenomenon known as 'seal heel nibble' when used with some ABS systems. This occurs when pressure is built up early in the piston travel – before it has travelled over the cut-off port – deforming the seal and leading to durability issues. To eliminate this, AP Racing has switched to a centre valve configuration, which replaces the traditional cut-off port.

The pulsing action of an ABS system introduces more vibration – not just into the brake system, but into the car as a whole, explains Hamblin: "It's not like a road car, where a typical driver might go for a whole year without activating the ABS. I can point to a trace and show you significant ABS intervention five or six times every lap, so the impact it has on things like seal wear is an order of magnitude different to a road car." ▶



BELOW The use of horizontal forging has kept down the price of the entry-level PRO SPORT competition range, while still enabling the use of the same piston, seal and seal groove technology found in professional motorsport calipers

Brake-by-wire

Perhaps the biggest shift facing brake systems – at least in the top echelons of professional motorsport – is electrification. The approach to this varies. At one end of the scale, there are hybrid systems such as the spec package formerly used in the British Touring Car Championship, which apply passive regen essentially as an enhanced form of engine braking, with no brake-by-wire capability. At the opposite extreme, Formula E now harvests regenerative energy from both ends of the car and no longer uses conventional mechanical braking on the rear axle under normal circumstances (although a small backup system remains).

"Something like the BTCC system is comparatively simple and doesn't really impact the design of the brake system at all," comments Hamblin. "In contrast, Formula 1 now has ultra-optimised brake-by-wire systems that allow the teams to run smaller brakes – especially on the rear. Those systems rely on extremely sophisticated valving and control technology to do that safely."

The upcoming 2026 Formula 1 regulations could push things even further, with more regeneration capability leading to even smaller brakes.

> *"We've got high-temperature seal technologies and cooling strategies from motorsport being used on road cars with ceramic discs"*

"From the simulations we've seen, I wouldn't expect it to be as extreme as Formula E, but I think we're going to see the rear brakes get even smaller [than current F1 items]," he says. "The new regs will also allow 8-piston calipers and three mounting points for each caliper. This gives people a little more design freedom. I think there'll be a lot of simulation work to determine whether it's worth taking advantage of these new options or whether that just adds weight that you don't really need if you're doing a lot of it with the hybrid system."

Formula 1 teams are notorious for designing and manufacturing as much as possible in-house, but Hamblin says it's still very much a collaborative process when it comes to the brakes. AP Racing has two full-time engineers dedicated to Formula 1, as well as ▶

BELOW The anti-drag technology honed in NASCAR across the years has now found its way down to road cars

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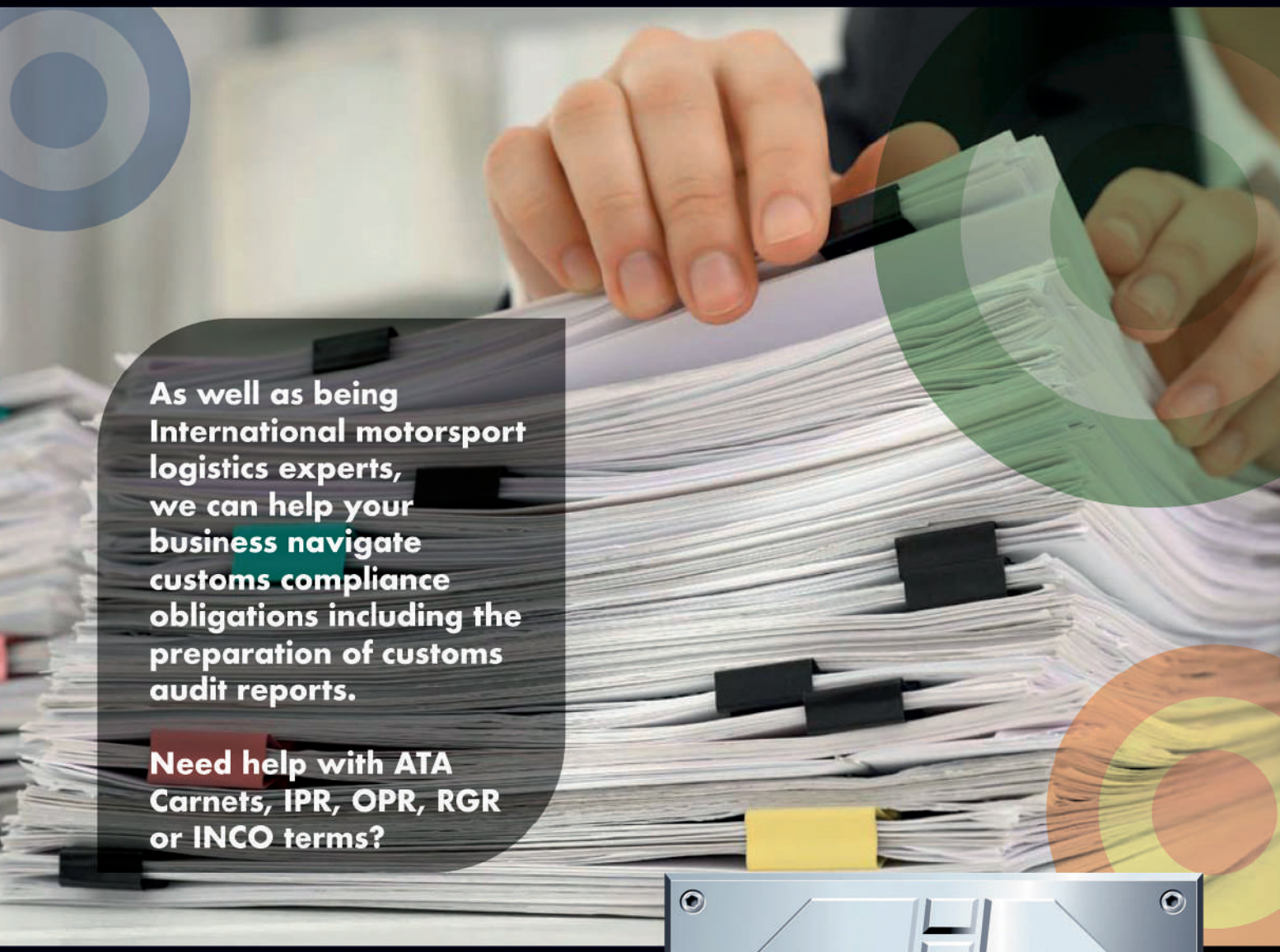

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"We work very closely with the teams on the cooling of the calipers, because aerodynamics is such a critical area in F1, but the mechanical and structural aspects are generally led from our side," says Hamblin.

Hydrogen

AP Racing is also keeping an eye on how hydrogen powertrains might impact brake technology. Hydrogen tanks are likely to add mass to the cars, and although the regulations for the ACO's forthcoming Le Mans H2 category have yet to be confirmed it's thought that this would be combined with a substantial hybrid capability (even for those using hydrogen combustion, rather than fuel cells). As such, weight increases seem inevitable, and this ties in with a general trend towards bigger and heavier cars right across motorsport.

"We think the brake systems are likely to get bigger on most cars. Certainly for the carbon-carbon applications, we expect to see bigger discs, but you can't fit much bigger discs inside 18-inch wheels. A 395 mm disc is about the limit currently, depending on the wheel design, so it will depend on whether the tyre manufacturers can move to 19- or 20-inch sizes," comments Hamblin.

The hardest challenge

While some areas of motorsport technology appear to be diverging from mainstream automotive, the new challenges facing brake systems, such as heavier vehicles and hybridisation, have very direct parallels to the road.

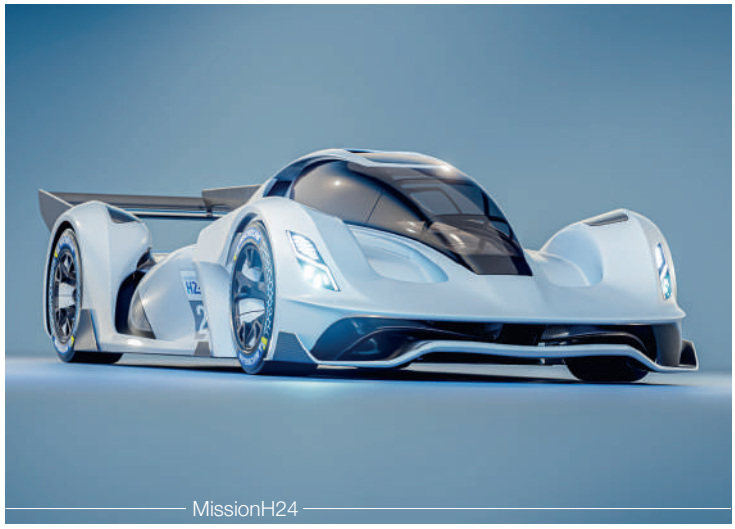
As well as OEM interest, there's already a strong demand for aftermarket brake upgrades for electric cars, particularly in the Chinese market, Hamblin explains.

"If you look at the aftermarket scene in, say, the US it's all about performance. In China, the first question is always 'what will it do to my range?' The brakes need to be more powerful [than the stock items], they need to look good, they need to offer better pedal feel, but that can't come at the expense of efficiency."

To ensure precision, high-performance braking systems minimise the amount of lost motion in the caliper. It's normal to have slight contact between the pads and the disc, which results in a small amount of residual drag. In a typical high-performance system this might be in the order of 10 Nm – barely enough to feel if you jack the car up and spin the wheel by hand, but enough to make ▶

ABOVE AP Racing supplied a range of calipers, brake discs and pads to more than two thirds of last year's Le Mans grid, including the winners of both the LMGT3 (pictured) and LMP2 categories

BELOW Hydrogen powertrains, for which MissionH24's H24EVO is a poster-child, will influence brake designs by adding mass to the cars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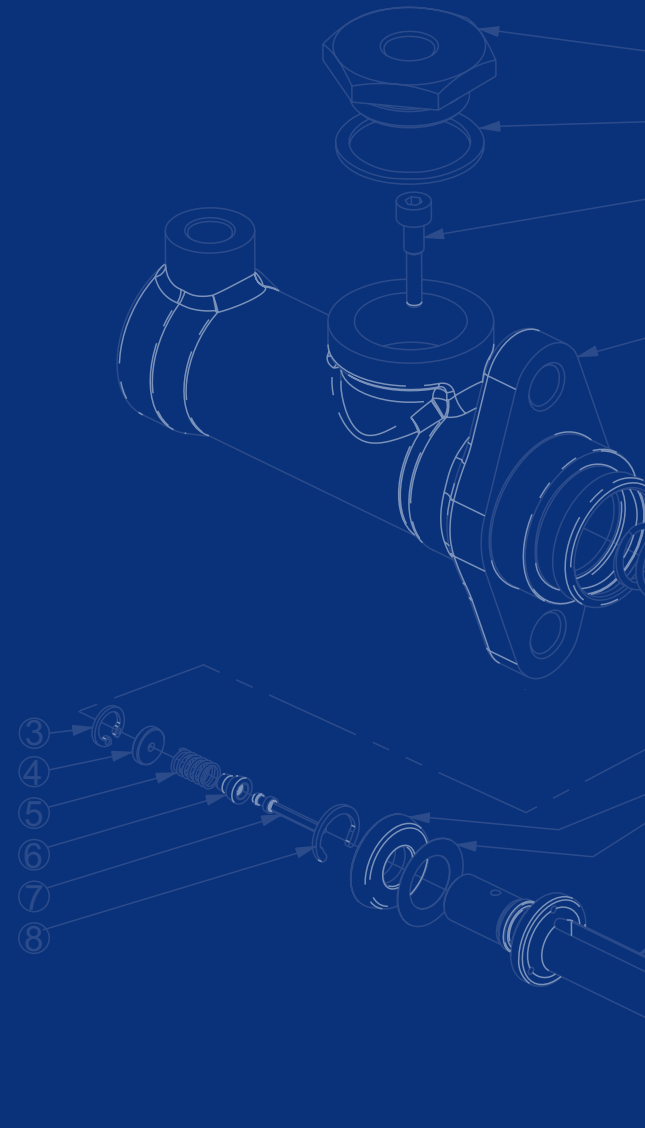
RIGHT AP Racing's new near-net forged Radi-CAL GT caliper, featuring its asymmetric design concept. The GT ranks are a hot battleground for the brake manufacturers

> *"If you look at the aftermarket scene in the US, it's all about performance. In China, the first question is always 'what will it do to my range?'"*

an appreciable difference if you're doing 180 mph round the banking at Daytona.

"It's not so relevant now that NASCAR uses a spec brake package, but previously on super speedways, the brakes were basically just there to get them back into the pits. You wanted everything pulled as far back as possible to eliminate drag the rest of the time," comments Hamblin. "Some of the seal technology that we now use on electric road cars comes from that work – understanding the influence of certain tolerances and certain design concepts on the pad control. When you're on the road or a

RIGHT An exploded view of the centre valve master cylinder. AP Racing switched to this configuration to eliminate the issues caused by the use of ABS with traditional cut-off ports



BELOW The 2026 F1 rules will offer more design freedom, allowing 8-piston calipers and three mounting points for each caliper

Courtesy of F1

conventional racetrack that becomes even harder than on a super speedway, because you need the precision there as soon as the driver touches the brakes."

Reduced unsprung mass

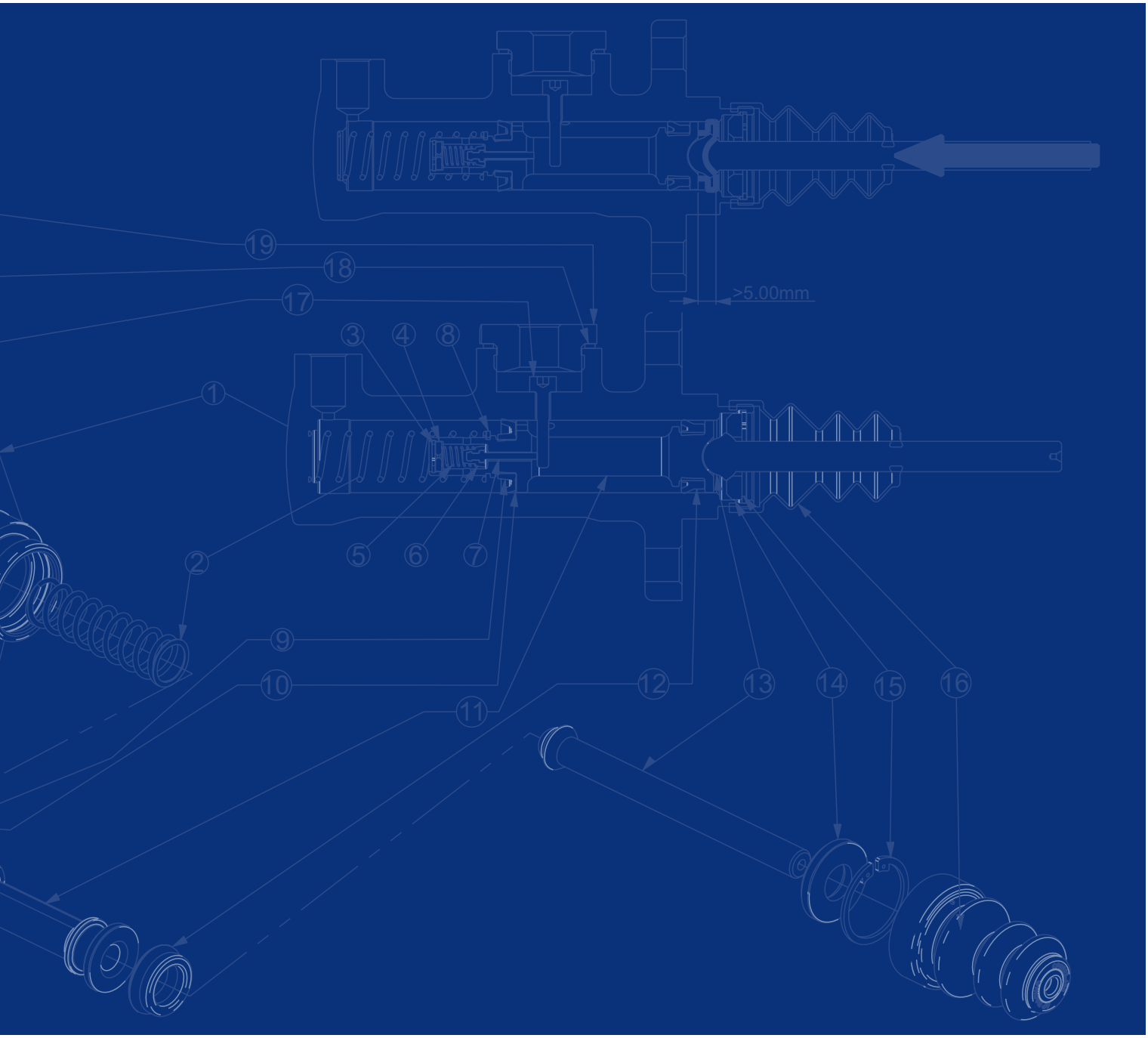
Weight reduction is another common factor. Many road-going EVs tip the scales at over two tonnes, but the emphasis is on engineering a vehicle that *feels* a lot lighter. Alongside tools like torque vectoring and rear-wheel steering, reduced unsprung mass can help to improve agility.

"Our vertically forged calipers can be two or three kilos per corner lighter than a cast caliper," says Hamblin. "Compared to a casting, you've got a better grade of material, you can go much more near net shape, and you can get much thinner sections as you don't have to flow the material, you just need to bash it down. In the top end road car stuff that we do you can see the motorsport-style body designs starting to come through."

On top of all this, road car brake systems face additional challenges that aren't generally present in motorsport.

"The road car market is a much harder environment, in some ways, to get right," comments Hamblin. "Not only have you got to deliver exceptional performance, but it's got to be quiet, it's got to be able to do high mileages without any maintenance, it needs to have all the environmental protections, and you've got much greater cost pressures too."

But it's a legacy of nearly 60 years in motorsport that has equipped AP Racing to confront these challenges. Proving that the right brake technology can still make all the difference.



THE TORQUE OF DAYTONA

Following IMSA's rollout of torque sensors for its GT machinery in the test at Daytona, **Sergio Rinland** discusses the joys of Balance of Performance

IF you want to control the flow of the Thames in Southend, you don't build a dam in Oxford... You build it near Southend.

With this analogy we presented on these pages, 14 years ago, the motorsport regulations concept of regulating the outcome of what we want to control, not one or two of its contributors.

For years, in order to control engine power, the regulations controlled engine capacity, air flow or fuel flow. To some extent, F1 still regulates power this way.

With the technology available today (and also 14 years ago!) it makes more sense that if we want to control and limit the power of a racing car, we measure that power (or torque and RPM) near the wheels, at the driveshaft (near Southend...) and that's it.

That is the way today that LMH and LMDh control power; no longer cc, number of cylinders or air flow: 'do what you want, but at the wheels this is the power curve we want to see', period! The fact that the ACO and FIA are tampering with BoP on top of it, is a matter to discuss another day.

Balance of Performance (BoP) has a bad reputation and well justified. No one with a racing purist heart likes it, but if BoP has a place, that is in GT racing. GT by its nature is a competition between cars built for road use, not necessarily with racing in mind. Every manufacturer designs and builds GT cars with different objectives. Yes, performance is one of them, but also brand image, tradition and why not owners' illusions. Once Horacio Pagani told me, "I don't sell cars, I sell dreams".

Hence, we have a Porsche 911 with its 6-cylinder flat turbo engine hanging at the back (tradition!); Lamborghini has an angular styling with a 10-cylinder aspirated mid-engine; Mercedes has a front V8 engine; or BMW with a saloon car base and so on. Every car is different in concept and architecture. How do you regulate such a disparity of vehicles to race together in fair competition without BoP? With great difficulty, as history shows.

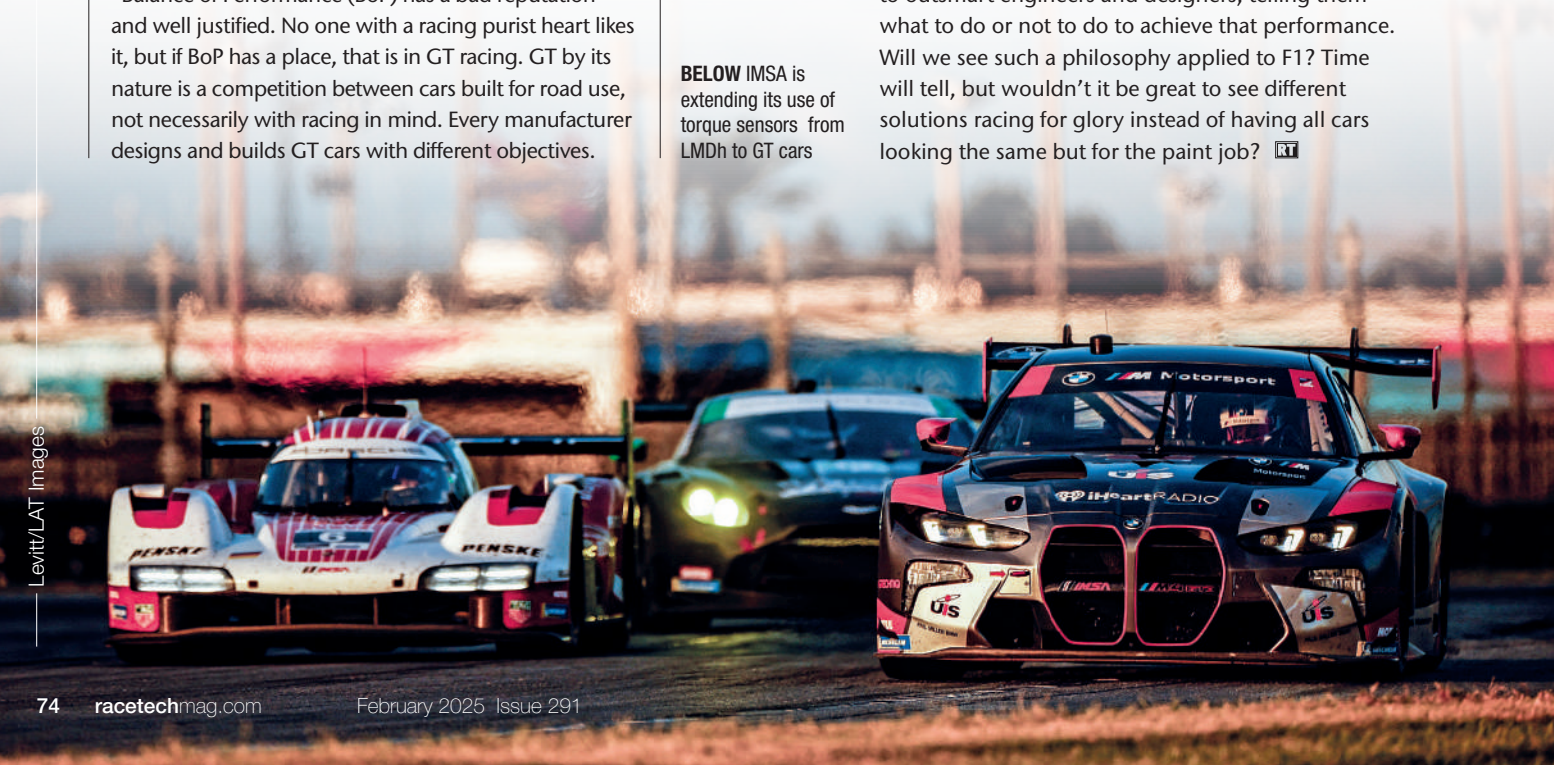
Up until now, the regulators tried to control power output by regulating the air going into the engine (near Oxford...), adjusting it accordingly based on ultimate performance. Now finally that is changing.

Having successfully introduced the concept to its LMDh/GTP category, IMSA is now extending the use of torque sensors at the driveshafts of GTD and GTD Pro competitors to monitor power output and adjust it from the Electronic Control Units (ECU) based on its criteria. This is a much more intelligent way of regulating and controlling power on such a diverse array of cars.

The next step for GT regulations would be to control drag and downforce. For that, you would need load cells at the suspension to measure downforce, as in LMH and LMDh, and also to take every car to the same wind tunnel or to the Catesby tunnel in Daventry to measure drag and downforce to equalize that part of the performance differentiator.

That way, the rule-makers will have more information and data on how to adjust power based also on individual aerodynamic performance due also to the disparity of shapes and designs. Again, as LMH and LMDh are doing now.

Slowly but surely, motorsport will be regulating the performance differentiators' outcomes and not trying to outsmart engineers and designers, telling them what to do or not to do to achieve that performance. Will we see such a philosophy applied to F1? Time will tell, but wouldn't it be great to see different solutions racing for glory instead of having all cars looking the same but for the paint job? RT



BELOW IMSA is extending its use of torque sensors from LMDh to GT cars

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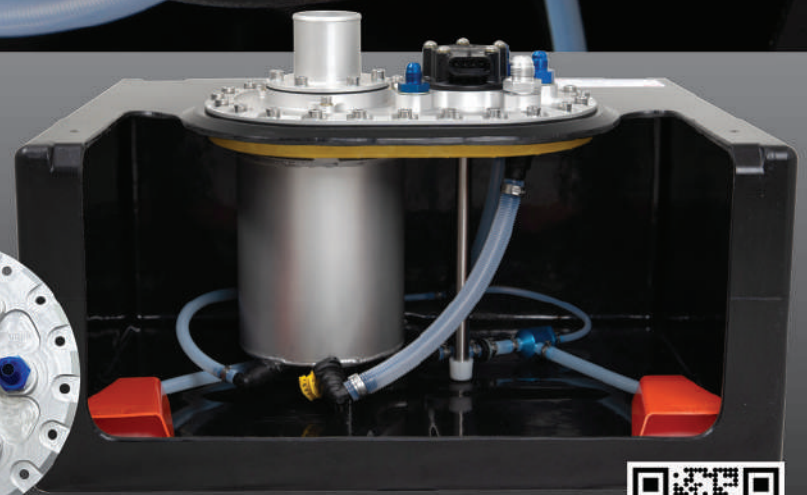

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